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Disciplinarity, Epistemic Friction, and the 'Anthropocene'



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PhD Thesis
University of Edinburgh
2018

Declaration

I declare that the work presented in this thesis is my own original work and that it has not been submitted in whole or in part for any other degree or professional qualification. The research is entirely my own except where otherwise acknowledged.

A handwritten signature in dark ink, appearing to read 'J Barber', with a long horizontal flourish extending to the right.

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Abstract

This thesis explores the scientific controversy over the ‘Anthropocene’, a putative new epoch of geological time conceived in 2000 by atmospheric chemist and earth system scientist Paul Crutzen. I trace the conception of the Anthropocene and explore its spread through a range of disciplines from the earth sciences to the humanities. Particular attention is paid to the Anthropocene Working Group (AWG) of the International Commission on Stratigraphy. This group was tasked with considering whether or not the Anthropocene should be subject to stratigraphic formalisation and be made ‘real’ insofar as the discipline of stratigraphy was concerned. The group’s efforts, and the wide-ranging response to them, reveal the challenge of making sense of knowledge as it moves across different disciplines, settings, and contexts. While the AWG was tasked with producing a specifically stratigraphic response to the rising prominence of the Anthropocene, in performing their investigation the group took on board wide-ranging multidisciplinary expertise. As well as raising questions about the appropriate criteria for the group’s investigation, the response to the group’s efforts from a diverse range of disciplines illustrates the disunity of interdisciplinary work. The movement of the controversy from scholarly journals into an increasingly public sphere reveals further questions about the relationship between scientific authority and society as a whole. While different communities disagreed about the scientific value of the Anthropocene, many shared in their recognition of the role this scientific framing could play in fomenting a political response to anthropogenic global change. This thesis argues that scholarly debates about the Anthropocene illustrate questions about authority, epistemic privilege, and the relationship between disciplines that have ramifications beyond the controversy itself.

Lay Summary

This thesis explores sixteen years of arguments over a novel concept, the ‘Anthropocene’. That concept suggests that human impacts have driven the planet into a new period of earth history. During the period this thesis covers, the Anthropocene grew to increasing prominence across a range of disciplines from the earth sciences to the humanities. And, by the year 2016, the concept was able to command the attention of the international media. At the heart of arguments over the Anthropocene lay a question about the extent to which disciplines could leave to others decisions about the usage of concepts which fall within their own areas of expertise. With the Anthropocene this was primarily a challenge for stratigraphy, the discipline that has been historically charged with the division of geological time. However, because the concept carried implications beyond the borders of this discipline alone, stratigraphers were not the only group affected by a concept whose expansive scope afforded it both scientific and political meaning. This thesis does not attempt to pre-empt the final outcome of the controversy. Instead, it explores how and why scholars seek to engage with concepts that might otherwise be nothing more than esoteric technical concerns for a more narrowly defined community. By drawing on extensive analysis of materials produced in the Anthropocene controversy and primary data collected from scholars who were willing to engage with the concept, this thesis argues that the Anthropocene controversy shows what happens when the boundaries between concepts and terminologies, between disciplines, and between science and society collide. And, I present an important case study that illustrates how the ‘facts’ and the ‘politics’ of a concept like the Anthropocene are unavoidably permeated by non-scientific values and motivations. In so doing, I extend discussions of interdisciplinarity and its particular role in the performance of contemporary research to explore what it means for scholars to pursue unclear goals with uncertain outcomes in the name of societal relevance.

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List of Acronyms

AGU	American Geophysical Union
ANT	Actor-Network Theory
AWG	Anthropocene Working Group
ESS	Earth system science
BRICS	Brazil, Russia, India, China, South Africa
CFCs	chlorofluorocarbon gases
CNRS	French National Centre for Scientific Research
EMIC	Earth-system model of intermediate complexity
GSA	Geological Society of America
GSSA	Global Standard Stratigraphic Age
GSSP	Global Boundary Stratotype Section and Point
HKW	Haus der Kulturen der Welt
ICS	International Commission on Stratigraphy
IGBP	International Geosphere-Biosphere Project
IGC	International Geological Congress
IUGS	International Union of the Geological Sciences
NCT	Niche Construction Theory
OECD	Organisation for Economic Co-operation and Development
PAGES	‘Past Global Changes’ Project
SSK	Sociology of Scientific Knowledge
SQS	Subcommission on Quaternary Stratigraphy
SRC	Stockholm Resilience Centre
STS	Science and Technology Studies

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Chapter 1: Thesis Introduction

1.1. Introduction

This is a story of ‘the Anthropocene’. It is a story of how scientists and scholars negotiated the meaning of that novel concept and terminology between early 2000 and late 2016. It is a story of the scholars, disciplines, and institutions that gave that term meaning and weight and why they did so. And, it is the story of why scholars seek to engage with new concepts and what it is they believe to be at stake with them. The analysis I present here discusses the Anthropocene with regards to questions of authority, epistemic privilege, and the relationship between disciplines. I contribute to literature on interdisciplinarity by considering both how, and - crucially - why concepts move and what this means for the relationship between science and society.

In February 2000 the Anthropocene was a term spluttered out by a prominent scientist - Paul Crutzen - in a moment of frustration (Steffen 2013, p486). In that moment the Anthropocene simply stood to jolt a room full of scientists discussing global change and remind them that the relative climatic stability that had seen the establishment and growth of sedentary human civilisations was no longer a given. The Anthropocene meant that we were no longer living on a planet dominated by natural fluctuations in temperature driven by orbital variations, but rather in a time defined by the overwhelming dominance of human activities. That outburst was short, sharp, and provocative. It may not have been intended to ‘do’ anything more than silence the room, but it sparked muttering in the wings amongst the researchers in attendance. Maybe the man who had coined this new concept was onto something; maybe human activity really had driven the earth into a new geological epoch. By late of 2016 the Anthropocene had been everywhere: it had become the anchoring concept for a massive international research collaboration (Brondizio & Syvitski 2016), it was conjoined to normative ideas about how best to ‘steward’ the earth (Rockström et al 2009a; 2009b), it was the death knell for the modernist ‘Nature-Culture binary’ in popular scientific discourse (Lorimer 2016), a saviour paradigm that might bring

increasingly fractured disciplinary silos back into active communication (Dalby in Johnson & Morehouse 2014, p442), and - according to the editorial for *Anthropocene Magazine*¹ - a powerful tool for 'thought leadership' at the science-policy nexus. Clearly, there was much excitement and anticipation about what the 'Anthropocene' could be used to achieve across the raft of disciplines that attend in some way or another to the relationship between humans and the planet. Perhaps most importantly, all this excitement had emerged in response to a concept that seemed like it belonged to stratigraphic investigation, the practice that had traditionally dealt with the division of geological time and the upkeep of the formal International Chronostratigraphic Chart. In turn, this excitement made it unclear where scientific authority sat within the controversy, and left it uncertain what role that authority was to play.

1.2. This Study

Drawing on a broadly constructivist reading of science (Golinski 2005) - and the work of Hans-Jörg Rheinberger (1997) and Charles Alan Taylor (1996) in particular - I explore how the Anthropocene concept was given meaning and made to move. Accepting the production of scientific claims to be a complex process, this thesis is interested in the ways in which scholars engaged themselves in this scientific controversy. In exploring how science "actually gets done" (Taylor 1996, p7; also Gieryn 1999), I pay specific attention to the acts of rhetoric through which scholars moved and gave meaning to the Anthropocene concept. With a focus on the imagined ends to which scholars mobilised claims, I use the Anthropocene controversy to paint a picture of how scientists and scholars applied various representations of the world to achieve differing outcomes. In so doing, I ask which worlds their variously competing visions of the Anthropocene brought into being, which social relations they enabled, and to what effect (Mol 1999). This approach also encouraged me to step behind the specific claims being made in the controversy to explore embedded conversations about what knowledge ought to be in the context of an environmental, social, and cultural dispute (Fuller 1993). And simultaneously allowed me to situate the specifics of the Anthropocene controversy

¹ <http://www.anthropocenemagazine.org/about-us/>

against a rising clamour to ‘be interdisciplinary’ that has on-going implications for the institutional structuring of knowledge production (Jasanoff 2013).

While the contingency and spatial specificity of knowledge production is well-worn ground in constructivist literature, I recognise the on-going and pervasive influence of an ideological description of science that helps perpetuate a narrative of universal truths where scientific claims meet the public (Collins et al 2010). Against this context, I note efforts to rewrite the relationship between science and society to ensure greater relevance and accountability (Nowotny et al 2001) and the impacts of these efforts in producing an equally powerful ideology of interdisciplinarity. In exploring the implications of this ideology where various practices actually meet over a - nominally - shared concept (Barry, Born & Weszkalnys 2008), I consider the challenge of asserting authority across disciplines when knowledge claims trigger shared concerns (Osborne 2013). In tracing the Anthropocene as it expanded from a neologism within one discipline, to an epistemic burden for another, and finally fractured into a looser discourse, I note the powerful role that societal relevance played in stabilising claims despite epistemic frictions over their meaning. After all, it was a notionally shared dialogue about ‘doing’ something with the Anthropocene - expressed in the language of “maintaining” the earth (Chin et al 2013, p2) and guiding the “responsible” use of resources (Oldfield et al 2013, p2) - that led Anthropocene-centred journals to consolidate around various ‘inter~’ or ‘trans~’ disciplinary missions for the concept. Finally, I note the consequences of driving this controversy to increasing prominence in support of unclearly positioned political sentiments. Rather than extending the climate conversation to more accurately reflect its normative dimensions (as per Hulme 2009), I consider the risk of scientists and scholars doubling down on the use of the authoritative language of scientific truth to convey the urgency of their findings (Ezrahi 2004). And, I note the inadequacy of any discrete epistemic authority to adequately mediate upon a concept that sat in within, between, and beyond the reach of any single discipline.

To perform this research, I identified and analysed 385 peer reviewed articles and scholarly book chapters that engaged with the controversy, alongside 72 more

journalistic materials with active stakes in shaping the Anthropocene debate. I combined this analysis of Anthropocene literatures with 39 in-depth semi-structured interviews, 19 open-ended surveys (performed with AWG members exclusively), and 13 email correspondences (largely with participants who were otherwise unable to commit to interview). These 71 primary data sources corresponded to the perspectives of 55 individuals, with - for example - 12 AWG members consenting to perform a full interview upon returning a completed survey, and other interview participants responding to on-going discussion via email correspondence after completing interviews. While the literature served as the primary vehicle through which the Anthropocene was debated, made to move, and through which various visions of the concept were given validity and meaning, my primary data analysis allowed me to better interpret the 'empiricist repertoire' of published arguments to investigate what was hidden in the accounts that played out in the literature. In this way, I was able to explore the views of individuals in the controversy, make sense of what they felt to be at stake with the Anthropocene, and identify what they stood to gain through their own interventions (Gilbert & Mulkay 1984). To date, no scholarly work has gone beyond the literature to do this.

I drew upon 19 participants from the Anthropocene Working Group, whose efforts played a central role in driving and shaping the controversy. Alongside these AWG members I performed interviews and email correspondence with 13 'technically' motivated interlocutors in the controversy from the disciplines of archaeology, climate science, ecology, geology, geomorphology, pedology, physical geography, and Quaternary science, and 12 'politically' motivated interlocutors in the controversy from the disciplines of anthropology, environmental science, environmental economics, environmental philosophy, human geography, neomarxist critique, and postcolonial studies. Each of these participants actively helped to shape the controversy through their engagement, either by advocating for the role that their particular disciplinary expertise could play in consolidating a better understanding of the Anthropocene phenomenon, or by promoting the adoption of the concept amongst their own disciplinary communities. Interviews with the editors of 2 of the 3 Anthropocene-centred journals provided a crucial perspective on the efforts to shape the controversy into a

productive shared discourse, and interviews with 8 members of an Anthropocene-named research group illustrated how epistemic frictions reverberated through the controversy. In analysing these materials I made particular use of the ‘analysis of scientific discourse’ (ASD) to examine how accounts of the Anthropocene were organised to portray actions and beliefs, and to discern the motivations of interlocutors in forwarding their specific claims (Gilbert & Mulkay 1984). Drawing upon the empirical programme of relativism in the sociology of scientific knowledge, the combined analysis of both the literature and primary data allowed me to demonstrate the openness and interpretative flexibility of the arguments made in support of competing visions of the concept (Collins 1981b; 1981a; Collins & Evans 2002). And, this combined approach allowed me to consider the ways in which broader social forces intervened and shaped the development of the Anthropocene concept (Yearley 2005).

1.3. The Anthropocene Controversy

The rising popularity of the Anthropocene after Crutzen’s coinage and consolidation of the concept led to the establishment of an Anthropocene Working Group (AWG) who would operate under the auspices of the International Commission on Stratigraphy (ICS) and the International Union of the Geological Sciences (IUGS). The group’s task was to assess whether or not this putative new division of geological time should be formally appended to the stratigraphic column, and in effect, to carry the stratigraphic response to a concept that signalled important relations to that discipline. On August 29th 2016 - sixteen years after the initiation of a controversy over this new ‘epistemic thing’ (Rheinberger 1997) - the University of Leicester issued a press release on the Anthropocene that drew the attention of the world’s media. Timed to coincide with the 35th International Geological Congress in Cape Town, South Africa, this press release announced to the world that the AWG were confident in the stratigraphic reality of their findings (University of Leicester 2016c). The AWG had long professed a desire to produce a formal proposal for consideration at this important meeting of the foremost specialists in their field (AWG 2014; 1x interview). However, despite arriving to the fanfare produced by the world’s media, the group’s presence in Cape Town was a

relatively subdued affair. Rather than a bold proclamation, the group presented a trio of papers in a session entitled 'The Quaternary System: Precision and Reliability in Global Correlation'. While they provided a detailed update on their efforts, the group stopped short of making a formal proposal (Zalasiewicz et al 2017b). Instead, they discussed the appropriate methodologies for discerning sedimentological evidence of anthropogenic impact on the planet, and presented a sequence of potential lower boundary dates for the onset of this putative new geological epoch.

The AWG had initially intended to convene an entire session at the International Geological Congress around the Anthropocene, but had received limited feedback or interest from prospective attendees and ultimately abandoned this idea (1x email). Despite the widespread media interest in their activities, and despite engagement with the Anthropocene across a whole raft of disciplines, the geological community were undecided about the concept, its value, and its implications for the discipline of stratigraphy. Frustrated by the media interest that the AWG had generated, the group's representatives in Cape Town were instead swamped with "very terse" emails from stratigraphic colleagues who accused them of being conciliatory and deliberative with the geological community while being too forthright and direct with the media (1x interview). The AWG might have been satisfied that the Anthropocene was a real phenomenon, but they had yet to convince the community of stratigraphers who could assure that the concept be formally ratified and appended to the International Chronostratigraphic Chart. Given tensions with the institutional machinery of stratigraphy, one member noted the 'bravery' of members and the "unconventional challenge" their efforts presented for the ICS (1x survey). The group's efforts until this time had helped to grant the Anthropocene popularity amongst countless other disciplines. However, because Crutzen had gifted the Anthropocene a notionally stratigraphic name, this act of formalisation was now required to lend the concept 'reality' in a communal sense.

More importantly, while the AWG initiated their own - nominally stratigraphic - investigation in response to the spread of the Anthropocene within the earth system

science and broader earth science communities, they had come to embrace certain non-stratigraphic elements in their own thinking. In performing their investigation the group had pooled a multidisciplinary base of expertise. Alongside specialist stratigraphers, the group welcomed earth system scientists, climate modellers, ecologists, historians of science, a journalist, and even a maritime lawyer into their ranks. Embracing a process-driven earth system science vision of the Anthropocene in particular, the group were left with a desire to produce a stratigraphic concept that would not only draw insight from outwith the discipline, but one that could travel beyond its borders. And, in expanding the scope of their vision of the Anthropocene some members in the group began to imagine political and cultural implications for their concept. Recognising that there was more at stake with the Anthropocene than the 'mere' division of geological time, the AWG's prolific output drew recognition, commentary, and response from an ever-broader set of disciplinary voices beyond the earth sciences alone. Cutting across disciplines, this wide-ranging and disparate interest stretched the parameters of the Anthropocene controversy far beyond the boundaries of stratigraphy. In turn, that ambition towards 'inter~' and 'trans~' disciplinarity became a part of the very appeal of the concept. Despite its fractional nature and multitudinous forms, a range of voices had embraced the Anthropocene as a way to bridge perspectives on the question of human impacts on the planet. Despite this enthusiasm, the leadership of the ICS became increasingly concerned about a concept that had grown without their oversight or input (Finney in Carey 2016).

While the Anthropocene sustained a kind of interdisciplinary interest, the different meanings with which scholars imbued the concept left it signalling contradictory messages. The Anthropocene may have become an immutable fact of global change for the earth system science community, but for others it represented nothing more than a useful metaphor. For certain voices the Anthropocene was simply an "empty" and "objective" scientific label to describe a period of dramatic change (Rockström 2015), while for others the Anthropocene represented a problematic breaching of the cultural boundary that separates science from politics (Stirling 2015a; 2015b). All parties negotiated their relationship with the concept in complex ways. Those who publically

proclaimed the concept's scientific status still recognised the political possibilities of a concept that could leverage the weight of scientific authority. On the other hand, those concerned about the epistemic privileging of a new natural science concept in rapid ascendance themselves helped to promulgate the concept in their attempts to deconstruct and reshape it. What looked from the outside like a question about the age of the earth and how best to define it, was really a lens to explore the relationship between disciplines, how they meet, as well as where and why they are drawn into tension.

At the heart of the controversy lay a single fundamental challenge about the extent to which stratigraphers could leave to others decisions about the usage of a concept that signals such a close relationship to their own discipline. The final response to that challenge is not yet known. In time the institutional machinery of stratigraphy will produce an answer - of sorts - when they decide whether or not the Anthropocene is a worthy addition to the International Chronostratigraphic Chart. Their answer will be necessarily definitive - a 'yes' or a 'no' - but will carry broad consequences even if it is later modified or even completely overwritten. If they accept the Anthropocene for its stratigraphic merit, they will also anchor the concept and give it greater authority and currency irrespective of how others choose to use it. In effect, they will make the concept 'real' where it is currently only putative. If, on the other hand, the stratigraphic community ultimately rejects the Anthropocene they will create a bizarre kind of disjunction. The phenomenon that the Anthropocene concept signals might still be real for the communities that already accept it as such, but the relationship between the term and the discipline that gives the concept so much of its scientific cachet would be severed. Were this to happen, adopters of the Anthropocene might have to readjust their usage to reflect that the concept was more explicitly cultural and discursive than strictly formal and scientific. If the Anthropocene lost its appeal to being both, then perhaps it would generate less interest from all parties in the controversy. I cannot pre-empt the final position of the stratigraphic community, but I do explore the corollary of the challenge they must themselves address. That is, how and why do scholars seek to engage with concepts that might otherwise be nothing more than esoteric technical

concerns for a more narrowly defined community? In this thesis I argue that the Anthropocene controversy shows what happens when the boundaries between concepts and terminologies, between disciplines, and between science and society collide. And, I present an important case study that illustrates how the ‘facts’ and the ‘politics’ of a concept like the Anthropocene are unavoidably permeated by non-scientific values and motivations. In so doing, I extend discussions of interdisciplinarity and its particular role in the performance of contemporary research to explore what it means for scholars to pursue unclear goals with uncertain outcomes in the name of societal relevance.

I performed this analysis by asking three key questions.

What is the Anthropocene concept and who was involved in its spread?

- *What did the concept of the Anthropocene mean for various actors and institutions?*
- *How did those meanings change in different settings and contexts?*

How was the Anthropocene given meaning, made to move, and why?

- *What value did various actors and institutions perceive in the Anthropocene to justify their engagement with the concept?*
- *What did these actors and institutions seek to ‘do’ with the concept?*
- *How did their understanding of the concept translate to other groups?*

What are the broader implications of the Anthropocene controversy involved?

- *What were the implications of the Anthropocene controversy for the actors involved?*
- *What does the Anthropocene controversy teach us about the ways that disciplines interact with one another?*

- *What does the Anthropocene controversy teach us about the way that science meets society?*

The first question served to structure my unpicking of the Anthropocene controversy itself and the ways in which the meaning of the concept shifted across different contexts and settings. The second question guided the way in which I explored why different interlocutors were driven to engage with the Anthropocene and what benefit they saw in their engagement. The final thematic question served to organise my consideration of the implications of the controversy, and helped me to shape the particular findings of the Anthropocene controversy to a more generalised set of findings about interdisciplinarity and the relationship between science and society.

1.4. Other Scholarship on the Anthropocene

When I began writing this thesis in 2014 there had been limited critical work on the controversy. This has since changed, and there now exists much thoughtful commentary on both the controversy itself, and the possible implications and ramifications of the concept's spread. Some of this work - written across the disciplines of geography, history, environmental ethics, and ecocriticism - was written to serve as introductions or primers to the Anthropocene for unfamiliar audiences. Other works, often knowingly critical deconstructions of the concept and the controversy, take on a more 'reconstructivist' edge (Woodhouse et al 2002). As texts they similarly help to make sense of the Anthropocene for new audiences, but - despite their attempts to assess and diagnose the challenges presented by the concept's proliferation - they were an irreducible part of the debate, not something outside or above it. That is to say, some of this work sought to both make sense of, and simultaneously influence the trajectory of the controversy. Knowingly or unknowingly, both kinds of work were part of a pattern of scholarship that helped to drive the Anthropocene to increased prominence. Because of the particular role that some of this work played in the controversy itself, I return to much of it in greater detail in Chapters 7, 8 and 9 when I expand the scope of

my investigation to account for the wide range of disciplines that sought to engage with the Anthropocene.

Nonetheless, I believe there is value in sketching out some of the more important contributions to this growing body of literature. This serves two functions. Firstly, it helps me to situate this thesis in response to an existing body of work with which my own is in conversation. And, more importantly, it allows me to illustrate a number of trends in that literature and highlight the ways in which this thesis offers its own - different - contribution. First amongst these trends is the relatively piecemeal nature of critical scholarship produced on the Anthropocene to date. The second is the clear interests at play in the few major works on the Anthropocene. This is not to describe existing work as somehow incomplete, it is simply to acknowledge the particular concerns expressed in these works and place them alongside my own desire to offer a wider perspective on the movement of knowledge through the controversy. Whether dealing with the implicit politics of the concept or in explaining the reality of the physical phenomenon of epochal change for a specific audience, this scholarship does not synthesise a more complete story grounded in the what, how, and why of the concept's social construction. Where much of this literature discusses the Anthropocene in terms of what it teaches us about the (physical and political) world, this thesis - uniquely - treats the Anthropocene controversy as an opportunity to excavate scientific argumentation and the movement of knowledge. In so doing, I aim to expand spatial understandings of knowledge production to account for how and why concepts move.

As one of the first scholars to critically consider the Anthropocene concept and its implications, geographer Noel Castree has noted that the little work that has been done is largely unconnected (2014b, p460). Similarly, in an exploration of the 'parameters' of the controversy, science studies scholar Johannes Lundershausen notes that in spite of great enthusiasm for conversations to take place across disciplines, in practice discussion of the Anthropocene controversy has taken place in largely separate domains of scholarship with too much work considering its own audiences in isolation (2015, p311). For example, stratigraphers might address the question of a lower

boundary to the Anthropocene, but they are far less interested in the performative ambiguity of terminology that defines critical social science engagement with the concept (p314). As a consequence valuable insights remain underdeveloped, including Brian Cook's recognition that the Anthropocene is "even more interesting when its mobility and mutability across other knowledge fields is considered" (Cook et al 2015, p239). Without this work the Anthropocene remains a "super-concept" with a supposedly self-evident mass appeal (p240) without there being enough work to consider how that appeal has been constructed and maintained, or why. Following Castree's suggestion (2014c), I concur that geography is a well-placed discipline to deal with the Anthropocene controversy and begin to draw together a set of fragmented engagements with the concept into a more complete narrative and a more complete analysis. One that seeks to trace the onset of the controversy, follow its diffusion through different actors and institutions, and explore how different engagements reverberated with one another.

Not only does geography possess a rich history of scholarship that seeks to chart the movement of knowledge in and through society, but - without either romanticising or essentialising the discipline - geography's historic focus on questions of the 'human' and 'natural' worlds lends practitioners a fluency in the language that has been mobilised in the Anthropocene controversy (Castree 2014c). Whatever the specific dimensions to the claims being made, the Anthropocene remains a geoscientific claim about the world in which we live. As a result, there is value in exploring the implications of the circulation of this new imaginary of the globe, both on its own terms (see Cosgrove 2003), and in terms of its implications for geography. To the extent that the Anthropocene is capable of generating both mutual interest and friction across the divide between positivist and interpretivist engagements, this divide has long been a feature of geography departments. While calls to place greater emphasis on interdisciplinary research are a persistent feature of 21st Century academic life - a call that I argue has its own implications for the Anthropocene controversy - critical geographers have a long history of navigating the epistemic frictions at the centre of their shared 'disciplinary donut' (for example Harden 2012; Demeritt 1996). This attentiveness is well evidenced by the large

number of thoughtful special editions published by geographers in the years since I began work on this thesis. These efforts include those led by Brian Cook, Lauren Rickards and Ian Rutherford (2015 and the articles therein), Elizabeth Johnson and Harlan Morehouse (Johnson & Morehouse et al 2014), and Amelia Moore (2015 and the articles therein). Alongside interesting work in science and technology studies by both Lundershausen (2018; 2015) and Helmuth Trischler (2016) that feature essentially spatialised discussions of the controversy.

While the majority of the scholarship on the controversy has focussed on a relatively narrow remit, a number of comprehensive works on the Anthropocene have been published in the past couple of years. These include historians Christophe Bonneuil and Jean-Baptiste Fressoz's (2016) *The Shock of the Anthropocene*, neomarxist historian Jason Moore's (2016) edited collection *Anthropocene or Capitalocene?*, and Romantic scholar and ecocritic Jeremy Davies' (2016) *The Birth of The Anthropocene* to name but a few. During this time the AWG were working on their own book on the Anthropocene with Cambridge University Press for publication sometime in 2018 (AWG 2017), and member Erle Ellis was drafting the manuscript for his own introduction to the concept for Oxford University Press' *Very Short Introductions* series (Ellis 2018). The AWG and its members have persistently sought to present a vision of the history of the Anthropocene concept that largely serves to support their on-going efforts towards formal stratigraphic ratification (for example Steffen et al 2011a) rather than really delving into the history of the concept. However, the group's tendency to link the Anthropocene as-they-make-it to a long historical narrative has generally been limited to a few "linguistically related and short-lived antecedent terms" that obscure as much as they reveal about the group's thinking (Rickards 2015, p280). As a result, I can only encourage more complete works that offer greater clarity. Nonetheless, I remain sceptical of the ability of the AWG to account for the contingency and the messiness of the development of either their own vision of the concept or the broader interest in it. That their own treatise is due for publication prior to any decision being made by the International Commission on Stratigraphy suggests to me that it will primarily serve to support the group's evidential case in favour of formalisation. Indeed, the proposed chapter outline that the group has

circulated for this work (AWG 2017) suggests that the group simply wishes to synthesise their existing arguments, and will address the controversy and its implications only in the final chapter.

With this in mind, the comprehensive reading of the Anthropocene concept offered by Bonneuil and Frescoz seems particularly welcome. However, in making their argument that we need to better attend to the history of the thinking that has enabled the Anthropocene concept to develop, Bonneuil and Frescoz also homogenise the entire earth and environmental science community as it has engaged with the controversy into an 'Anthropocenologist' in-group (p49). This move on Bonneuil and Frescoz's part is consistent with a tendency in critical literature to overstate the hegemonic power and influence of the AWG as part of a broader argument about the invisibility of social science work that serves as both motivator and justification for intervention in the controversy (see Castree 2014d; 2017b). In my view there are dangers to simplifying the narrative of the Anthropocene too much in this way. An Anthropocenologist in-group might support a valuable consideration of the deeper historical and political processes at play in the generation of planetary crisis in Bonneuil and Frescoz's work, but it does so at the cost of a more nuanced recognition of the complex social dimensions behind a highly contested scientific concept and the varied perspectives of the members of what is - in reality - a quite diverse set of actors. As a result we still lack a study that gets behind the general consensus positions that are espoused by the AWG in their writings and more public utterances (see Barry & Maslin 2016) or those who have responded to the group's efforts. This is something that I have tried to attend to in this thesis.

Finally, I note that beyond a few scholars (see Castree 2014d, p242; 2014b; 2017b; Barry & Maslin 2016) much critical work on the Anthropocene accepts the epistemic claims of geoscientific Anthropocene proponents at what is, essentially, face value. Instead this work seeks to engage with what the Anthropocene is said to mean and the implications of those meanings, or it seeks to engage because the term creates an opportunity to pursue existing research within "a new... ostensibly sympathetic frame hailing from the geosciences" (Castree 2014d, p240). For example, Eva Lövbrand and a

number of co-authors (Lövbrand et al 2015) have pointed to Bruno Latour's *We Have Never Been Modern* (1993) to argue that despite its restatement through 'the Anthropocene', postmodern scholarship has long contended that "natures never come ready made" (p213). This is well-trodden intellectual ground, but by pouncing on the Anthropocene as a kind of proof that postmodernism was right about 'nature' and is now finally receiving public recognition from scientists (see also Lorimer 2016) this work fails to engage with the very making of the concept. Thus despite its own inherent strengths, this scholarship has been broadly unwilling to question what it might mean for the Anthropocene if the institutional machinery of stratigraphy decides against formalisation. For Jeremy Davies the possibility of such a disjunction is simply a "reminder that... [formal] ratification... is not the most important thing about the stratigraphic version of the Anthropocene" (2016, p90). I find this view problematic, because even as these scholars seek to expand understanding of the Anthropocene and colour its consequences beyond a purely stratigraphic fact-making exercise, their somewhat 'opportunistic' (see Pickering 1984) embrace of the concept arguably helped to naturalise the concept. As a consequence, the Anthropocene gets to be an "intellectual zeitgeist" (Lorimer 2016, p118; also Baskin 2015) and a "leitmotif" (p120) ungrounded in stratigraphy or any particular discipline, with no attempt to dissect how and why this concept has been given meaning and been made to move.

As a result there is a kind of complicity here amongst some critical work by which commentators on the controversy "help to make what they purport merely to announce" (Schaffer 2013, p57). For example, in offering a critical reflection on the Anthropocene controversy, Jamie Lorimer offers an 'analytic typology' for parsing out the different ways in which scholars and institutions have engaged with the term (2016). In constructing this typology Lorimer acknowledges the ability of actors to move between the different typological roles he establishes so that they ultimately hold multiple positions within the broader controversy. As a commentary on the controversy Lorimer's points seem apt, but he muddies his own typology by publishing under the title of the Anthropocene elsewhere (see Lorimer 2012; 2014). As a result I believe it is important to problematise the professed non-commitment to the Anthropocene and its naming in

this work (2016, p132) that sits uneasily alongside the desire to stick with the term and make use of it elsewhere. Jeremy Baskin's critique that advocates of the Anthropocene seem to declare "the end of nature in an empirical sense" while simultaneously clinging "to the idea of Nature in the conceptual sense" reminds us both that this is a literature of contested boundaries, and of the complex role of terminologies in the movement of scientific concepts (p18; also Castree 2017b). Whatever the value of individual works I remain sceptical of the idea that a commentator can both offer critical insight into the Anthropocene controversy, and simultaneously use it uncritically to push another intellectual agenda.

In his *The Birth of the Anthropocene*, Davies invites increased attention to the Anthropocene concept from the environmental humanities but neglects to make sense of how and why controversy has arisen over this particular term. In suggesting that it is "unfruitful to denounce the word [Anthropocene] in blanket terms if your real target is only one particular way of using it" (2016, p41). Davies notes instead that the Anthropocene has been "fissiparous from the start" (p44). For me, this reflects a tendency of scholars to dismiss the fundamental faddishness of the Anthropocene in certain contexts, and the implications that such a "transient" (ibid) use of the concept might have. Perhaps hypocritically, Davies himself decries the risk that as a terminology 'Anthropocene' be used only to make research seem relevant as long as it concerns the history of humans and any dimension of the environment over the last 10,000 years (p52). Likewise, while Lorimer might at least reflect briefly on the faddishness of the term he is nonetheless willing to afford it a kind of weight because the Anthropocene "will leave its semantic and sensory traces in popular practices and lexicons" irrespective (2016, p123). In this way, the faddishness of the Anthropocene is acknowledged but just as quickly subsumed within the value of the broader controversy because the debate this helped to foment was "extremely generative of conversation and creativity" (pp 122-123; also Dalby in Johnson & Morehouse 2014, p444; Cook et al 2015). As a consequence, some of this interest has helped to split the controversy into a set of endlessly fractured micro debates, in which critical commentary in one domain need not reflect and impact upon efforts in another. Case in point, as Castree notes

concerns about the politics of the Anthropocene expressed in the social sciences and the humanities have not had a marked impact on thinking amongst earth and environmental scientists despite their intention to do so (2014d, p239).

I want to suggest that where critical scholars refer to the Anthropocene as a “brilliantly provocative new label” (Davies 2016, p70) they allow excitement about the intellectual possibilities of the Anthropocene - despite the on-going stratigraphic controversy - to create challenges that have not yet been adequately addressed. These challenges include the impossibility of disambiguating a parallel (stratigraphically) formal Anthropocene and its use from a (broader) ‘informal’ use of the concept in the literature (see Barry & Maslin 2016, e00022). In response I prefer to view the Anthropocene as an inchoate whole, and believe that too little attention has been paid to the way in which the Anthropocene sits in a complicated interstitial space between disciplines and between the institutions of scholarly research and the public. There is something singularly fascinating about a concept that “has scientific respectability despite not being an accepted scientific term” (Baskin 2015, p10), and I believe that we need to pay more attention to what Brian Cook has called the “heterogeneity of perspectives simmering under the title” ‘Anthropocene’ (Cook et al 2015, p237) without assuming that heterogeneity to be necessarily virtuous. In this way, I wish to avoid the tendency to fantasise about a purely constructive debate that would see us iterate on the Anthropocene until its contradictory logics are simply resolved (Maslin in Maslin & Barry 2016, e00022). As Lauren Rickards has pointed out, the scaffolding that gives concepts their weight eventually recedes into the background, leaving little more than a black-boxed vision of the concept itself (2015, p282; also Castree 2015a). Thinking too much about what happens next with the Anthropocene concept, and not enough about where it has come from, risks unintentionally performing that black-boxing.

To this interesting but scattered set of critical works I add a contribution that lies somewhere between the recognition of the Anthropocene as an earth-shaking “philosophical event” that usefully escalates the narrative of global change beyond the “sclerotic discourses of chronically inactive international institutions” (Rowan in Johnson

& Morehouse 2014, p447), and a “depoliticising meta-abstraction that conceals the constitutive fractures of sociopolitical relations” (p448; also Swyngedouw & Ernstson 2017). Without questioning the reality of anthropogenic change, I tell a story that retains the complexity and fragmentary messiness of the Anthropocene controversy and considers how the work of different communities reverberated through one another without attempting to tame the concept that emerged as a result of those efforts. And, I respond to the controversy in terms of the challenge it presented for disambiguating what was meant by whom and for what ends when they adopted the concept, and I ask why it was that the Anthropocene served the intellectual interest of any particular engagement. As historian of science Hans-Jörg Rheinberger has noted “we cannot use simple concepts correctly until we understand the process of simplification from which they are derived” (1997, p28). In this sense, my aim was to understand the Anthropocene as a controversy, rather than to make an evaluative statement on what the concept said or did in political or intellectual terms or, indeed, whether any perspective was ‘right’ or ‘wrong’. It was in this spirit that I have tried to make sense of the fragility of the Anthropocene concept before an inevitable ‘historical eventuation’ leaves us with a far simpler origin story (ibid, p74).

1.5. Thesis Structure

Absent the introduction and conclusion, the body of this thesis consists of eight chapters: a literature review, a methodology, and six empirical chapters. Here I briefly sketch out the contents of each. The empirical chapters follow a loose chronology but are organised primarily by theme. For example, Chapter 4 establishes the dimensions of the controversy as I have understood it and its popularisation within the earth system science community between the years 2000 and 2007. However, in tracing the implications of the vision of the Anthropocene this community established, this chapter also draws on material that was published as recently as 2015. Chapters 5 and 6 focus on the efforts of the AWG between 2008 and 2015, and their attempts to both make sense of the Anthropocene for stratigraphy and negotiate the multidisciplinary of their thinking. Likewise, in establishing this story, I consider the work of the AWG’s precursor

group within the Geological Society of London between 2001 and 2008. Chapter 7 and 8 expand my exploration of the controversy to consider the activities of those outwith the AWG. While these chapters are largely confined to the period between 2012 and 2016, as above, I refer to work published as far back as 2001 to better establish the characters, motivations, and arguments that I explore. The final empirical chapter - Chapter 9 - returns its focus to the AWG but uses the expansion of the controversy into the semi-public domain of newspapers, websites, and blogs to explore how the different actors, domains, and spaces of the controversy impacted upon one another. Taken together, these chapters present a narrative arc that starts with the establishment of the controversy through to the AWG's attempts to resolve that controversy for stratigraphy. And, from the broader interest these efforts generated, back down to the AWG in order to explore the implications of the controversy for the group, their efforts, and their thinking.

Chapter 2: Literature Review

In the literature review I position this thesis as a spatial study of the actors and institutions engaged in producing scientific claims. Drawing on Hans-Jörg Rheinberger, Charles Taylor, and Thomas Gieryn in particular, I explore the value of various constructivist approaches to understanding the production of scientific knowledge, and, I explore the factors at play in the making of, stabilisation, and resolution of controversy. Beyond this, I use the literature to consider the implications of a powerful ideology of 'interdisciplinarity' in contemporary academia, and its implications for the authority of competing knowledge claims. In elaborating upon this context, I sketch out a vision of the increasingly complex relationship between science and society that forms the backdrop to the Anthropocene controversy.

Chapter 3: Methodology and Ethics

In this chapter I outline my methodology and my approach to analysing the Anthropocene controversy. As well as detailing the use of multiple methods in making

sense of the controversy, and the different ways in which data and analysis contributed to the development of this thesis, I use this section to consider the ethics of research. In particular, the challenges of performing research on sceptical participants aware of their roles in a growing and increasingly public controversy and cautious about adverse interest. I also explore the politics of disclosure, and the risk of exacerbating the very interdisciplinary tensions that I identify as sitting at the heart of the controversy.

Chapter 4: The Onset of the Anthropocene Controversy

In this first empirical chapter I trace the onset of the Anthropocene controversy, and explore the period following the coinage of this new concept at the lips of Nobel-prize winning chemist Paul Crutzen. In the story that follows, I pay particular attention to the consolidation of this ad-libbed neologism into a more substantive argument, and the backfilling of an earth system science logic to the Anthropocene concept. I explore the implications of that earth system science logic, as well as the efforts to reconcile Crutzen's ad-lib with a (constructed) genealogy of precursor concepts. Finally, I consider the institutional stakes at play in the adoption of this particular vision of the Anthropocene, and the role that Crutzen's individual status played in affording that nascent concept intellectual weight.

Chapter 5: Epistemic Burden and the Establishment of the Anthropocene Working Group

In this chapter I explore the early response to the Anthropocene from within the discipline of stratigraphy, and the establishment of a dedicated working group under the auspices of the institutional machinery of that discipline. In detailing the early efforts of this group I pay particular attention to two dynamics. Firstly, I characterise this response in terms of an epistemic burden by which stratigraphy needed to intervene in the use of a terminology - 'Anthropocene' - whose epochal suffix augured direct stakes for their own disciplinary practice. Secondly, I consider how the AWG reached beyond the

borders of the discipline and established a multidisciplinary team to perform their stratigraphic investigation.

Chapter 6: Multidisciplinary Tension and the Role of the Anthropocene

In this chapter I continue to explore the AWG and their efforts to make sense of the Anthropocene. Here, I pay particular attention to the multidisciplinary nature of the group's efforts, and I consider how this multidisciplinary impacted upon the form of the group's investigation. I argue that the embrace of earth system science logic in particular began to alter the AWG's perception of what could or should be considered within the purview of stratigraphic inquiry. Drawing close attention to the import of earth system science's future orientation, I consider how some group members not only began to imagine the political implications that stratigraphic formalisation might carry in terms of raising awareness of anthropogenic global change, but also began to understand political influence as a part of their very reason for being.

Chapter 7: Invisibility and Opportunism in the Spread of the Anthropocene

In this chapter I trace the response - across a range of disciplines - to the efforts of the AWG, and the effect of this response in massively expanding the parameters of the Anthropocene controversy. I argue that in spite of highly disparate modes of engagement, many interventions shared a mutual concern with the 'hegemonic' influence of the AWG in defining the Anthropocene. And, I note how the motivations to get involved in the controversy often had less to do with contributing to stratigraphic argument than they did with a fear of disciplinary erasure that would leave smaller and less prominent disciplines 'invisible'. In exploring these interventions, I pay particular attention to a collective recognition of the narrative potential of the Anthropocene that led many interlocutors to adopt the Anthropocene despite objections to the concept. Finally, I consider how a broader and looser consensus was established around a specifically 'informal' vision of the Anthropocene.

Chapter 8: Discursive Space, Epistemic Friction, and the Fractional Coherence of the Anthropocene

In this chapter I consider both the discursive lock in of the Anthropocene through the establishment of a number of Anthropocene-centred journals, and the implications of this discursive lock in for the controversy as a whole. In so doing, I draw particular attention to the role that these journals played in stabilising a vision of the Anthropocene that had less to do with the stratigraphic investigation of the AWG and more to do with a vision of 'inter~' or 'transdisciplinary' scholarship. Nonetheless, I question the suitability of this - by-now expansive - informal vision of the Anthropocene as a useful vehicle through which to deliver this interdisciplinary vision. In particular, I note the tensions at play where adopters with divergent understandings of the value and meaning of the Anthropocene met, and consider how the agreement to share the concept across disciplines unmoored the Anthropocene from any particular disciplinary understanding.

Chapter 9: Media Interest, Semi-Public Debate, and Boundary Work

In this final empirical chapter I consider how the controversy impacted back upon the AWG's efforts. I pay particular attention to the movement of the controversy beyond scholarly journals and into a range of semi-public spaces, and note the increasingly febrile tenor of arguments that emerged as a result. Acknowledging the growing concerns of the International Commission on Stratigraphy in response to a controversy that had upset the normally quiet back room practice of their discipline, I consider the ways in which the AWG sought to navigate the heightened scrutiny emerging from their parent body. Despite making an effort to better present their arguments in the language of stratigraphy alone, I note the on-going belief of AWG members that the Anthropocene held both scientific and political meaning. And, despite reorienting their efforts to assuage the concerns of prominent voices within the institutional machinery of the discipline, I note the group's on-going belief that their vision of the Anthropocene would stretch and alter stratigraphic practice in important ways.

Chapter 2: Literature Review

2.1. Introduction

This literature review has two aims split across three sections. The first aim is to set out the theoretical foundations and the tools that I employ in this thesis. Following this structure, the first section outlines the theories that support my arguments and understanding of the Anthropocene controversy. I explore various constructivist approaches to the production of scientific knowledge in order to argue that the Anthropocene needs to be understood as an ‘epistemic thing’, an irreducibly vague, paradoxical, embodiment of that “one does not yet know” (Rheinberger 1997, p28). As a result, this section positions this thesis as an act of mapping out the actors and institutions engaged in the production of a piece of (nominally) scientific knowledge, explores the factors at play in the making of, stabilisation, and resolution of controversy, and finally establishes what I believe to be at stake for interlocutors engaged in controversy in general terms. The second aim of this chapter is to explore the situational context for the thesis in order to locate the Anthropocene controversy firmly within a contemporary moment. I split this aim across two further sections. The first of which considers the implications of a powerful ideology of ‘interdisciplinarity’ on the interests and motivations of scholars. I argue that the pressure ‘to be interdisciplinary’ demands complex responses to complex problems (see Barry & Born 2013; Nowotny et al 2001) and creates a context into which the epistemic thing called the Anthropocene appears perfectly calibrated to fit. The final section of this chapter moves beyond the question of interdisciplinarity to consider the relationship between science and society in broader terms. Here, I argue that the seemingly simple referents of ‘science’ and ‘society’ refer to an increasingly complicated set of arrangements defined by the expectation for scientists to perform public-facing work and respond to media interest in their findings (see Gieryn 1999; Taylor 1996). These pressures, combined with a zeitgeist of distrust in expertise create challenges for environmental science in particular. Rather than extend the climate conversation to more accurately reflect its moral and political dimensions (as per Hulme 2009), I suggest that the Anthropocene presents a risk for

scientists who seek to double down on the use of the authoritative voice of scientific truth to convey the urgency of their findings. This risk suggests a crucial need to further develop a critical and reflexive understanding of environmental science and its relationship with society (Yearley 2001; also Funtowicz & Ravetz 2008; 1993).

2.2. Constructing Scientific Knowledge

There are multiple approaches in the study of the construction of scientific knowledge. As a consequence, we can recognise that to talk of ‘the social construction of science’ has itself become an unhelpful catch-all that masks the partiality and contingency of a multitude of similar, yet differentiated, approaches to explain how scientific concepts are manufactured (see Rheinberger 1997, p17). Conflict between approaches has been a common feature of the social study of science (see Bloor 1999; Latour 1999a; also 1992; Collins 1985), and I recognise the need to be mindful of the compatibility of various approaches. That said, despite their professed differences, the boundaries between the history and geography of science, the sociology of scientific knowledge (SSK), and Actor-Network Theory (ANT) seems unclear. All draw upon similar sets of literature, mobilise similar examples, and concern themselves with explaining how it is that knowledge is made and moved. The glue, as it were, is a consistent “transpositivistic challenge to objectivity” (Rheinberger 1997 p22). Broadly speaking, much conflict between approaches regards the particulars of language and recursive arguments about agency, with compatibility lost in arguments about what it is their terminologies refer to (Golinski 2005, p39). The thought of grouping them by their intended audience, rather than by the ways in which they resonate with one another seems unhelpful (see Taylor 1996, p76; Callon 2001, p60). Instead, this thesis simply seeks to map the individuals, institutions, and the divisions involved in the production of an epistemic thing called the Anthropocene and the controversy caused by its production. In that sense, this thesis is a spatial study, one that explores the acts of rhetoric that make the Anthropocene move and give it meaning in particular contexts, for whom, and to what imagined ends (Gieryn 1999). By shifting the focus beyond epistemology to consider the acts of rhetoric and demarcation that help constitute and

stabilise epistemic things we can expand our concern with how science “actually gets done” (Taylor 1996, p7). In this light, to borrow - where appropriate - from a broad suite of scholarship is an attempt to avoid delimiting the resources at hand while acknowledging the ways in which these many schools enhance our understanding of that discursive ‘doing’ of science (see Demeritt 1996). This is, in the words of Sheila Jasanoff, a ‘show don’t tell’ approach more interested in foregrounding the research object than in bending it to fit theory (2004; also Golinski 2005).

2.2.1. Epistemic Things and Stabilisation

The Anthropocene is an unstable, as-yet-unfixed concept. Investigating developments now, before they become formally adopted and ‘fixed’, or otherwise fully rejected, has significant methodological value. As Harry Collins (1975) puts it, “we get to see the strings before we’re left with a ship in a bottle and no idea how it got there” (p206; also Rheinberger 1997). Following scientific practitioners and academic researchers through the practices that constitute their work provides a valuable way of getting access to things that are normally denied to us. In particular, the practices and the acts of rhetoric that stabilise epistemic things and render them into ‘facts’. These acts take place in the here and now, before the ‘historical eventuation’ of repetition and time renders them invisible (Rheinberger 1997; also Gilbert & Mulkay 1984) and strips them of geographical context (Barnes & Dupré 2008; Powell 2007; Livingstone 1995). Thus, investigating both the production and circulation of knowledge provides a route to contesting the ‘view-from-nowhere’ assumption that is both hidden in public accounts of scientific work and mobilised by scientists themselves (see Haraway 1989; 1991b). Such work demonstrates instead that views do indeed come from somewhere, and that any notion of distanced objective ‘truth’ should be actively confronted as myth (see Shapin 2010; 1998). Paying attention to the spaces of science means attending to the times and places in which actors and institutions produce power, the way that movement transforms knowledge, and the ways in which actors and institutions appropriate knowledge in different times and places in ways that affect the interactions of other social actors (see Livingstone 1995, p13; also Foucault 2002; Said 1991;

Giddens 1984; MacIntyre 1988). In tracing knowledge from its humble beginnings we can also observe how it is that knowledge is made to travel, and can explore the spatialisation that epistemic things undergo in order for them to be both efficacious in their originary context and beyond (see Secord 2004; Livingstone 2003; 1995).

Exploring science in the making is an act of ‘recovery’, pulling the parts of the story that a heroic account of scientific achievement renders invisible back out into the daylight that we might gain better understanding of how knowledge is truly formed (see Naylor 2002). More profoundly, there is a politics to this desire to recover science. Donna Haraway (1991a) notes the profound injury that an “informatics of domination” has dealt to women, minorities and the non-human as a consequence of science practiced along patriarchal lines with limited societal oversight (also 1992; Demeritt 2000; Shapin 1990). Attempts to argue for the situatedness and historico-geographical contingency of knowledge has historically been viewed as denigration, because the messy reality of science suggests not a search for pure truth, but something that is deeply entangled with knowledge forms and practices that emerge from local lore (see Powell 2007). And yet, engaging critically with science is valuable precisely for the fact that it helps to generate better accounts of the world, and better ‘science’, that does not rely on the ‘God-trick’ myth of distanced objective knowledge to afford itself potency (see Haraway 1991b; also Demeritt 2001; Barad 1999; Collins & Yearley 1992; Nowotny 1979). Ultimately, when we fail to confront the processes that go into the construction of knowledge we miss out on conversations about what that knowledge ought to be in the context of environmental, social and cultural disputes (see Fuller 1993). These are conversations that nonetheless get embedded into that knowledge by virtue of the very process of its production at the hands of individuals who carry their own political commitments (see Naylor 2005; Demeritt 1996). As I will argue in this thesis, these conversations matter for the Anthropocene controversy.

A constructivist approach suggests that knowledge is not a pure intellectual achievement, but rather as set of processes in which people engage themselves (see Golinski 2005). This means that knowledge production is not the mere consequence of

replication by rote scientific rules, as the popular conception of disinterested, distanced, and objective science suggests (see Shapin 2010; Demeritt 2000; Haraway 1991b; Merton 1942). Instead, knowledge can be seen to be the result of skilled actors making pragmatic decisions about how to apply their craft. And further, that relations over authority - including the status and experience level of the scientific practitioner in question - affect this ability to make judgement decisions and afford them weight (see Golinski 2005; Shapin 1998; Rheinberger 1997; Barnes 1985; Collins 1985). A constructivist account also suggests that scientists must negotiate both the technical complexity of their skillset and their own mastery of that skill set, aspects that are themselves representative of the vested interests of the scientific communities in which they operate (see Golinski 2005; Livingstone 1995). Thus, a big part of the game of science is rhetoric, by which individuals and institutions are able to convince other relevant actors that their manufactured knowledge is the appropriate route to gaining some measure of power over the thing they wish to describe (see Haraway 1991; also Latour 1987; Secord 2004).

This is not to suggest a relationship that is always or only about control; it is simply to explain that terms are not neutral and that they have consequences (see Hornborg 2016). First and foremost, ideas reciprocate themselves by virtue of the fact that as scientists work through their ideas, and become more competent in the handling of their own experimental systems, the outcomes are increasingly shaped in the image of those very ideas (see Barnes & Dupré 2008; Thrift 2004; Rheinberger 1997). We can broadly refer to this process by which the 'truth' is established as 'truthing' (Powell 2007) or as 'blackboxing' (Latour 1987). In either instance the effort to tell a coherent narrative leads to unavoidable simplification. This process of making knowledge 'true' is difficult to articulate in accounts of science. Because such an account would need to draw in 'non-scientific' elements the proponents of ideas could view it to be an unhelpful diversion from that which they might hope to 'do' with their new claims. As a consequence, we are given an impression of constant forward momentum by narratives that trace the inevitable origins of an idea through to that 'how stupid of me not to have thought of this!' moment in which an epistemic thing takes on a more concrete status. But as

Thomas Kuhn (1996) has argued, any account that implies progress in this way is deeply problematic (also Serres and Latour 1995). As Jan Golinski notes, such whiggish accounts speak of scientific progress as if it were the story of how the “human mind gradually gained representational mastery over external reality” (2005, p3; also Shapin 2010; Barnes & Dupré 2008; Schatzberg 2004; Haraway 1992; Livingstone 1992). Thus, truthing is not a straight line from ignorance to mastery but a complicated process of negotiation, politics and power-plays; an ‘untidy’ craft that gets lost if we do not actively seek to tell its story (Demeritt 1996; Shapin & Schaffer 1985).

Beyond this a network of feedback loops means that knowledge production often refers back to itself, a process that is self-validating and self-reaffirming (see Barnes 1983; also Rudwick 1985). If theory is used to construct experiments, and experiments are designed to test that theory we can see how analysis is always built upon previous analysis, with the effect that an argument can effectively be referenced against itself. For Barry Barnes, this is both a process of institutionalisation - as scientists can refer back to previously socially institutionalised knowledge - and the process by which knowledge is socially institutionalised and sustained - through the ability of scientists to create a tidy insular language that serves their interests. The role of the institution becomes one of masking and stabilising these loops in ways that render them invisible, while also presenting a barrier to knowledge claims that emerge from outside. Harry Collins (1975) has also pointed to the way in which bootstrapping colours our understanding of what truth is; we tautologically define it by the very criteria we use to accept something as ‘true’. This means that when scientists work to validate or affirm any idea that pertains to the reality of the world they are, on some level, engaged more simply in conversations amongst themselves to negotiate results that are acceptable to the scientific community as a whole (see Kusch 2002). That is to say, the job of a scientist is not only to produce new claims, but also to represent those claims in such a way that the communities in which they work might recognise them as facts. Thus, when replicating an experiment a scientist is not simply checking findings against an external material world, but is rather negotiating the rules of replication (Collins 1975 p205). Once a scientist declares that they have successfully replicated an experiment,

they are in a sense claiming that the original and their replication are to be treated as being one and the same. This suggests an important role for constructivist accounts in illustrating the rhetorical strategies that give rise to the successful replication of an experiment (p208; also Shapin 1984).

2.2.2. Representation and What is at Stake

Differing constructivist approaches - particularly the sociology of scientific knowledge (SSK) and Actor-Network Theory (ANT) - have been subject to explosive debates over the question of how best to represent the process of knowledge formation and whom in the story to afford agency. ANT's offer has been to double the 'symmetry postulate' of SSK that asks that we treat 'good' and 'bad' knowledge as being subject to the same social forces, and suggest that we consider the roles that both the natural world and the sciences play in restructuring the social (Golinski 2005, p40). While ANT - in part - evolved from the foundations of SSK, its development saw a series of circular debates in which each party suggested the greater interpretive power offered by their relative positioning of agency (see Bloor 1999; Latour 1999a; 1992).² SSK theorists might reasonably offer that it is only social forces to which a sociologist can stake some claim of understanding, but those working with ANT can retort that the decision to work with social dimensions alone misses half the story (Callon & Latour 1992, p356). I am less interested in these debates than in the role that scientific representation plays in producing the world it nominally seeks only to represent. For me, the interesting question with an active controversy is not how effectively any given theory corresponds to the external reality of the world, but is instead about what any particular representation allows various actors to do in that world (Barad 1999; Haraway 1992). In this sense, scientific representations are not only transformative of us, but also transformative of the ways in which we can interact with the world in material ways (Demeritt 2001, p311). Attention to this curious space between representation and action helps to illustrate that the categories which exist 'only' as an artefact of

² For more on this conflict see Demeritt (1996), Golinski (2005), Jasanoff (2013), Law (2002), Pickering (1995).

instrumentation, and that which exists as 'real' phenomenon revealed by science are only ever decided upon the resolution of controversy (see Golinski 2005, p40; Latour 1999b). With his focus on showing rather than telling, geologist and historian of science Martin Rudwick's (1985) exploration of the settling of another geological boundary has deftly navigated this space. His exploration of the Great Devonian Controversy managed to demonstrate the complex interactions between the physical reality of the natural world and the epistemological construction of ideas that (nominally) pertained to it without centring his discussion on theory.

Rudwick's narrative in *The Great Devonian Controversy* begins in 1834 with the disagreement of two geologists, Roderick Murchison and Henry De la Beche, over the dating of certain petrified plants found in coals in the Greywacke strata in Devon. The controversy was settled six years later in 1840 with the introduction of the Devonian system and period. In dissecting the debate, Rudwick questioned whether the resolution of the Great Devonian controversy entailed anything more than 'the agreement to agree' of certain expert practitioners, or whether the outcome actually did embody a valuable and meaningful improvement in the human understanding of the planet (see also Barnes & Dupré 2008). As we have seen, retrospect channels our reading of controversy, implying that the Devonian system itself was the inevitable and natural outcome of a wholly neutral and 'scientific' investigation. This may seem particularly true for those geologists who make use of the Devonian as a matter of everyday routine. However, as Rudwick's analysis made clear the defining features of the Devonian controversy were the complexity, contingency, and non-inevitability of the arguments that ultimately resolved debate (also Rheinberger 1997). The data collected by Murchison and De la Beche demonstrated that global geological changes do not appear suddenly or with any real sense of synchronicity, and if that were the case then any division of the earth's geological history must be based on convenience.

As a result, Rudwick argued that neither 'discovery' nor 'construction' were by themselves adequate metaphors to convey the production of scientific knowledge in this instance. 'Discovery' would imply that the Devonian was a wholly unproblematic

disclosure of the natural world, and 'construction' leaned too far the other way by suggesting that the Devonian was only a product of social negotiation. Instead, Rudwick turned to the metaphors of 'shaping' and 'forging':

The Devonian controversy shows how new knowledge is shaped from the materials of a real natural world, malleable yet often refractory; but it becomes knowledge only as those materials are forged into new shapes with new meanings on the anvil of heated argumentative debate.

(Rudwick 1985, p455)

For Rudwick, the product of the controversy that is the geological period we call the Devonian could ultimately be considered as both an artefactual construct and as something natural. That is to say, the concept of the Devonian was evidently a social construction, and yet the idea could nonetheless serve as a reliable representation of the natural world, one that allowed geologists and stratigraphers - to this day - to do something in the world in which the Devonian exists (1985, p451). That Murchison and De la Beche were engaged in social negotiation over the meaning of actually existing material phenomena is a given for practitioners of SSK. By contrast, ANT would explain the role of these material phenomena as if they were not already a given, and afford an agency which equates to them also having their own place in the debate. Rudwick leaves both possibilities open, suggesting instead that we can only be certain the empirical work alone did not determine the resulting 'Devonian', and neither was it totally irrelevant to the outcome. Instead it had a "differentiating effect" on arguments, constraining what was ultimately a socially constructed representation so that it would remain as a "limited, but reliable and indefinitely improvable representation of natural reality" (p456). The product of this argument meant that there was now a Devonian, a new 'reality' (insofar as it could provoke meaningful interactions with that 'reality') manifest in the world and shaped by the very discourse around it (also Serres 2014; Barnes & Dupré 2008; Demeritt 2001). Regardless of whom we ultimately grant agency in this story, it was the acts of rhetoric that stabilised the Devonian that we can have some measure of access to. And, it was the way the Devonian was then inserted into

the broader scientific ecosystem that had practical and political consequences (see Rheinberger 1997, p222).

In this sense, the construction of an epistemic thing, and the acts of demarcation and stabilisation that allow for it to 'perform reality' constitutes a kind of 'worlding' (see Haraway 2011; also Demeritt 2001, p312; Barad 1999, p7; Mol 1999, p75). And, while there remains an active controversy over the exact nature of an epistemic thing and its definition we are required to deal with the multiplicity of worlds that are being constructed to achieve different ends by different actors and institutions (see Mol 1999; 2002a). Because this happens simultaneously there is a decision to be made between which version of an object to perform and favour at any given time (also Barad 1999; Law 2002; Latour 1988). That such a choice exists problematises any distinction between knowing, being, subjects, and objects such that we can "acknowledge that the world matters without taking for granted either the particular configuration of its matter or the processes by which it may be realised for us" (Demeritt 2001, p311). In such a view, reality does not simply precede the practices by which we interact with it, but is instead actively shaped by those practices. Thus the argument holds that we must ask "where those options [are] situated and what [is] at stake when a decision between alternative performances [is] made" (Mol 1999, p74). For Annemarie Mol these are questions of 'ontological politics'; the reciprocal relationship between the real and politics, politics and the real. In the case of the Anthropocene controversy it matters not only to ask how it is that this epistemic thing has been made, but also why. Which worlds do the variously competing visions of the Anthropocene bring in to being, which social relations do they enable, and to what ends?

2.3. 'Interdisciplinarity' as Ideology

The above has dealt with the construction of epistemic things, the role of rhetoric in their stabilisation, and what is at stake with them. As argued above, epistemic things derive a part of their significance from the question of how they will be used and to what ends. This is unpredictable in real time, and is instead constituted in the transit of an epistemic

thing into a broader ecosystem of science, where representations 'fix' its transient nature through repetition and by embedding it within wider systems. The power of any given representation is its ability to move, as the reality any given representation helps to create only makes sense within the context of that replication (see Rheinberger 1997; Latour & Woolgar 1986). However - as alluded above - this becomes a problem where alternative systems of representation come into play during controversy or otherwise. For the purposes of this thesis there were multiple epistemic lenses engaged over the definition and stabilisation of the Anthropocene. As this extensivity and breadth of interest in the Anthropocene demonstrated, something about this epistemic thing provoked individuals to actively engage with it. And in turn this 'interdisciplinary' aspect to the Anthropocene became part of its very appeal. Thus, the movement of the Anthropocene generated a challenging problem: the authority by which we are to know the concept was split and spread across different disciplines. As a result, that authority was located within a contested space, and this contestation helped to undermine attempts to produce stability.

2.3.1. The Rise of 'Interdisciplinarity'

Barry et al (2008) note that "disciplines discipline disciples" (p20). Their argument holds that disciplines exist to teach the next generation of practitioners the appropriate methods and concepts, as well as their correct application, to deal with that discipline's objects of concern. To be disciplined in this way means knowing when and how to discard 'undisciplined' objects. That is, in learning how to view a thing properly one also learns to 'unsee' improper things. As a result, disciplines are not only about the production of knowledge, but also the demarcation and exclusion of unwanted claims (see also Taylor 1996; Gieryn 1983; 1999; Shapin 1992). As Jan Golinski (2005) notes, the modern conception of the discipline emerged in the mid 19th Century with William Whewell's coinage of the term 'scientist', before becoming an immutable feature of the production of scientific knowledge. Over time this idea of the discipline was deeply embedded in the design of universities, and in turn helped to structure the production of natural knowledge around different disciplinary faculties rather than discrete research

objects or problems (also Abbott 2001, p123). In time, journals too came to reflect this commitment to the idea of knowledge as driven by the process of executing upon disciplinary norms (see Golinski 2005, pp 47-77; Schaffer 2013; Galison 2010). The 'dual institutionalisation' at play here, by which "disciplinary agents seek faculty for their own departments from within their own disciplines" whilst channelling graduates through PhD programmes so as not to jeopardise their future career prospects, has ensured the stability of disciplines at the institutional level (see Lang et al 2012, p40; Abbott 2001, p126; Turner 2000).

The concept of science as a unified thing and the idea of stable discrete disciplines that support it became popular rhetorics in the constitution of a culturally privileged authority for science (see Bush 1945; also Polanyi 1962). But, while this rhetoric of stability helped to constitute science's authority, such an account fails to acknowledge the ways that creative frictions over language, terminology, and practice have all contributed to breakthroughs in the scientific understanding of the world (see Collins et al 2010; Galison & Stump 1996). What gets lost in the dream of unity is the very "disunified heterogeneous assemblage of the subcultures of science [that] structures its strength and coherence" (Galison & Stump 1996, p13; also Mason 2016; Turner 2000; Hacking 1996). More importantly, recognising the disunity, contingency, and the specificity of place in the production of knowledge contributes to a much broader point. If the practices of disciplines have always been contested and negotiated then the thing that is now called 'interdisciplinarity' is something akin to a historical constant (see Barry & Born 2013; Barry et al 2008; Abbott 2001; Turner 2000; Kristeva & Defert 1998; Galison & Stump 1996; Klein 1990). What is new is the urgency with which a notion of 'interdisciplinarity' has emerged as a discourse in the institutional structuring of knowledge production (see Jasanoff 2013; Wodak & Chilton 2005; Kristeva 1998).

Bolstered in particular by the writings of Helga Nowotny (Nowotny 2006; Nowotny et al 2001; Gibbons et al 1994), this ascendance had less to do with the specifics of the relationship between disciplines - although it certainly has consequences for that - and more to do with the way in which the language of interdisciplinarity could be

hypostatized as a solution to a series of problems with the relationship between science and society. Implicit in Nowotny's writing is the notion of a divide between science and society, as well as a broader lack of accountability for science. In response, Nowotny presented models of inter~ - or even 'transdisciplinary'³ - scholarship as a solution to a crisis in the confidence of the work that science performs in and for society. For Nowotny, 'Mode-1 science' accepted and performed a clear distinction between science and society that bore only limited relation to the reality of scientific work in the contemporary world. Instead, her vision of 'Mode-2 science' was about bridging the boundaries between disciplines and bringing disparate modes of inquiry together to generate new integrative ways of knowing. Mode-1 science may have been the historical focus of intellectual endeavour and represented the archetype of science as envisioned along Mertonian lines of universalism, 'communalism', disinterestedness, organised scepticism, and the freedom to pursue research for its own value (see Merton 1942; also Barber 1987), and was consolidated in both the scientific imaginary and (US) science policy thanks to the efforts of Vannevar Bush and others (1945). Yet, for Nowotny this 'mode' failed to live up to its own values. Disciplines did not reciprocate on their freedom, but instead became insular, inward facing, and failed to generate solutions to social problems. In this narrative, Nowotny's solution was to suggest breaking the hegemony of disciplines in favour of other forms of accountability and instead judge scientific research against its application (see also Jasanoff 2013, p100; also O'Brien 2012). This vision of Mode-2 science would see inter~ or transdisciplinary groups come together for short periods of time to work towards the resolution of discrete problems that lie outside of the conception of any one discipline. For Nowotny and her

³ As Julie Thomson Klein notes, to read the literature on 'interdisciplinarity' is to encounter a profusion of terminologies (2000). There's the fairly standard "mouth-filling trio" of inter~, multi~, and trans~ disciplinarity (Strathern 2004, p70). But to this we might add cross~ disciplinarity (Barry & Born 2013), anti~ disciplinarity (Pickering 2013), notions of inter ~discursivity and inter ~textuality (Huggan 2008), as well as Klein's even broader palette of post~ disciplinarity and de~ disciplinarity (Klein 2005). The cynical approach here would be to acknowledge that the distinctions between categories here are effectively meaningless, except in practice (see Barry & Born 2013, Strathern 2004; Weingart & Stehr 2000). Indeed, as Catherine Lyall has noted, the terms 'interdisciplinary' and 'transdisciplinary' in particular are generally applied in an "unreflective and interchangeable fashion" (Lyall et al 2015b p151). Appearing most frequently in the literature, 'interdisciplinarity' seems to be the most appropriate generic term (Barry & Born 2013). Interdisciplinarity carries the greatest volume of writing on the subject even where that writing entails some criticism of the concept or opens up the possibility of plurality (for example Schaffer 2013; also Fitzgerald & Callard 2014; Huggan 2008; Strathern 2006; Klein 2005; 1990).

co-authors, research was to be an exercise in targeting problems and then mobilising the resources of the university to find solutions for the benefit of society. The applied focus of the work would mean that university researchers were more likely to find themselves collaborating with contemporaries in the industries their own efforts stood to serve, and were more likely to be judged by the outcomes that their work helped to deliver. As a consequence, the supposedly self-serving discipline-oriented hierarchies of the university would be levelled out to produce loose organisational structures that involved the end user group at the design stage of research (Nowotny et al 2001). In favouring the prefix 'trans~', Nowotny suggested that this new mode of knowledge production was 'transgressive' in its unwillingness to respect either institutional boundaries or those drawn more broadly between science and society (see also Frodeman 2013; Weingart & Stehr 2000). Research would be less 'blue-sky' in its orientation, less concerned with findings alone, and more about making active interventions in the world (Lang et al 2012, p26).

2.3.2. Authority in a Crowded Room

In dissecting the various 'types' of interdisciplinary relationship, Barry, Born, and Weszkalnys (2008) point to three persistent archetypes: integrative-synthesis, subordination-service, and agonistic-antagonistic (p28; Van Leeuwen 2005). Integrative-synthesis appears to broadly map to the perfect fantasy of interdisciplinary interaction in that it envisions two disciplines coming together and creating a new greater whole, hopefully resulting in some form of epistemic transformation. Subordination-service implies a mode of interaction in which the relationship is defined not by a mutual co-production of information, but by disciplines falling into a hierarchical framework. A common example of this relationship would be art-science in which the artistic partner does not seek to add to or particularly destabilise the assumptions made on the part of the involved scientific practice. Rather the artistic involvement is reduced to simply promoting - through extradisciplinary means - the value of the primary discipline's work. This model can produce a kind of stability by virtue of limiting disruptive change to the epistemic practices of those who get involved. More problematically, for the soft

sciences this model has been the justification for an increase in art-science funding in the UK and it risks positioning social scientists as translators whose role is to simply adopt the 'correct' natural science definition of a concept (Barry & Born 2013, p11). Nonetheless, it is also important not to reduce these kinds of relationships to a simple binary of hard science setting the agenda for the soft sciences and the arts when they interact. Born and Barry suggest that the converse is equally plausible, with scientists devoting time and resources in response to the desires of the involved artists despite this not advancing their own research agendas (ibid). The final mode, agonistic-antagonistic implies for Barry et al a more productive mode in which the intention is to challenge the "intellectual, ethical or political limits of established disciplines or the status of academic research in general" (2008, p29; also Barry & Born 2013). That is, the agonistic-antagonistic mode of interdisciplinarity challenges extant knowledge practices of all partners with the "aim of reconfiguring their boundaries, objects, and problematics" (Barry et al 2008, p30). While all three of the above types of interdisciplinary relation can be said to overlap to an extent - or even shift entirely over the lifetime on an interaction - the distinction between these modes provides a valuable heuristic by which to locate a politics of authority at play when disciplines come together in negotiating over an epistemic thing.

The tendency when interdisciplinarity becomes a key concern in research is that there is no way to discern whose authority gets to count where, when, and why (see Strathern 2004; Coles & Defert 1998). One might maintain a commitment to a healthy plurality, and nonetheless recognise where this can become a problem. For example, individuals might work towards a shared and synthetic vision, but dependent as they are on their own training and their own logic, they might not recognise that they understand the object in question differently from one another (see Collins et al 2010). For the so-called hard sciences an institutionally inculcated conviction in the validity of their approach is not matched by the soft 'humanistic' sciences, which are far more likely to settle on partial and contingent descriptions of ephemera than they are to come down on anything in absolute terms (Haraway 1991, p189). Thomas Osborne explains this issue by drawing on Donald Rumsfeld's infamous February 12th 2012 Department of Defence

news briefing response about 'known knowns', 'known unknowns' and 'unknown unknowns' (2013, p83). By rescuing Rumsfeld's Orwellian non-answer and converting it in a useful metaphor, Osborne suggests a key difference "if not by nature... then certainly by degree" between the hard sciences' and soft sciences' 'cultures' of investigation. The natural sciences are used to dealing with known unknowns: that is, generally, natural scientists have a sense of the limits of their knowledge, as well as some sense of how to test those limits. By applying known methods and procedures to problems they know exist, they can discern better methods and resolve to make knowable the unknown. By contrast the humanistic soft sciences tend to operate with unknown knowns. For example, it might be recognised that certain institutions are problematic, but it requires getting in deep with those institutions to understand the nature of the problem. By contrast with the above, the outcome is known, but the process is not. From the perspective of the hard sciences this represents a methodological fault because the humanistic sciences get lost in things we already know something about, and with no real plan of action. Analysis emerges later, and from the outside looks a little something like blagging. But this methodological fault is really the ideological virtue of the humanistic sciences. As Osborne argues, to go perform sociological research knowing what you want to find would produce rote, ideological research (2013, p85). Without overstating or essentialising either approach, this generalised and encultured difference in practices (p83; also Abbott 2001, p34) allows the hard sciences to perpetuate the narrative by which 'universal truths' ultimately prevail (also Collins et al 2010, p9).

In a wide-ranging critique of the ambiguous application of 'interdisciplinarity' in postcolonial studies, Graham Huggan (2008) notes that where ideas and methods are freely borrowed, then retooled to serve the purposes of one's own (extant) critique the moniker of interdisciplinarity becomes a bit misleading. Huggan suggests that while there may indeed be value in this kind of work it is important to acknowledge that this kind of work is 'intertextual' or 'interdiscursive' more so than strictly interdisciplinary. In a sense, borrowing smatterings of text or keywords entails a lesser rupture with disciplinary norms than it must to rethink one's disciplinary predilections (also Klein

1990). For Huggan this is not “a nitpicking semantic distinction but an important indication of the continuing disparity between theoretical ambitions and practical achievements” where interdisciplinarity is lionised as a pre-packaged solution to a broader problem with the way that institutions like the university produce knowledge (Huggan 2008, p6; also Barry & Born 2013; Strathern 2004). Osborne refers to a similar kind of practice in more baleful terms as ‘poaching’ (2013, p91). Poaching might provide an exciting transgressional sheen to work within one’s own discipline, but it is likely to highlight a deficit in knowledge when presented back to those in the discipline from which the poached concept had originated. Instead, poaching is nothing more than the ‘product of a kind of disciplinary deficit’ (p86) a lack of understanding plastered over with the application of novel terminologies and new metaphors. The argument follows - quite simply - that one cannot reduce everything to metaphor all the time (also Biagioli 1996; Fine 1996). Case in point - despite earlier work that attempts to synthesise the notion of interdisciplinarity in more expansive terms (1990) - in Julie Thompson Klein’s (2005) work on the humanities in the American university system it is a comfortable trading of ideas between philosophically like-minded approaches to unshared problems that seems to define her sense of ‘interdisciplinarity’ (also Kristeva 1998). If nothing else Klein’s example illustrates the massive variations in the possibilities of this thing called interdisciplinarity (pp 11-16; also Riesch 2014; Klein 1990).

The distinction that Osborne draws between disciplinary ‘parasitism’, ‘trespassing’, and ‘poaching’ opens up a special kind of problem. For some disciplines parasitism is the norm, “a part of their very style of being disciplinary, not something to do with interdisciplinarity as such” (p86). We could point to cultural studies or sociology to reinforce this point (see Barry & Born 2013; Klein 2005; Abbott 2001) but a more pertinent example would be to return to geography. Geography is a discipline that has long struggled to negotiate its own ‘inherent’ interdisciplinarity and the epistemic challenges that this presents (for example Lee et al 2016; Whatmore 2013; Harden 2012; Harrison et al 2004; Demeritt 1996). Despite the synthesis of methods and practices that defines the discipline, this innately interdisciplinary character is not outwardly apparent. This matters where there is institutional pressure on the idea of

‘interdisciplinarity’, because the discipline that is already integrative conversely ends up unable to excite funders because it is not seen to be doing something new (see Osborne 2013; Whatmore 2013). As a result, the deployment of these various rhetorics of interdisciplinarity can be situated not strictly as differences in research practice, but rather as an ideology to be applied to achieve any number of different outcomes (see Schaffer 2013; Barry & Born 2013; Barry et al 2008; also Jasanoff 2013; Osborne 2013; Pickering 2013; Wodak & Chilton 2005; Hacking 1996).

The impact of this ideology on the contemporary landscape of academia cannot be understated: interdisciplinarity is at the forefront of the research policy agenda - for example ESRC (2009), European Commission (2007), National Academies (2005) - as a response to social pressures to change how research is done (see Lyall et al 2015a; Foray & Sors 2014). It has had a profound impact on the institutional structuring of research (Lyall et al 2015b), has led to greater governmental oversight of research councils to ensure that research targets core societal concerns (Demeritt 2000), and has altered the autonomy of researchers to set their own agendas (Henkel 2005). And, despite the challenges that interdisciplinarity presents for training within disciplinary institutions (see Lyall & Meagher 2012; Osborne 2013) the concept has traction in journals and publications in fields as diverse as neuroscience (Fitzgerald & Callard 2014; Fitzgerald et al 2014) to English literature (Moran 2010), sociology (Abbott, 2001) to environmental science (Hicks et al 2010), let alone with the Anthropocene where it had its own central relevance (for example Brondizio et al 2015). Whether it is the tedious grind of grant applications skewed towards an unstated idea of ‘interdisciplinarity’ (see Whatmore 2013), the impossible and conflicting metrics for measuring good ‘interdisciplinary’ outcomes (Bornmann 2013), or the pressure of trying to produce work that goes beyond the purely “tokenistic” marshalling of the concept of ‘interdisciplinarity’ (Lyall et al 2015b, p157), the influence of this ideology is pervasive. In spite of growing pressure to produce interdisciplinary work, there remains little consensus on what interdisciplinarity means in practice (Rau et al 2018, p267; Lang et al 2012, p25). Little surprise, then, that some scholars refer to the idea of ‘interdisciplinary anxiety’ (see Coles & Defert 1998). Interdisciplinarity as an ideology

rests on such an unclear proposition that it appears more like another criteria against which to hold academics to account. It is at best a distraction that ignores the historical reality of disciplines' own capacity to be inventive, and at worst a unhelpful faddish trajectory for research that prevents the cultivation of the 'disciplinary' expertise of new specialists (see Wodak & Chilton 2005, pxiii) with material consequences on the kind of work that can be expected to gain funding (Huggan 2008; Klein 2005).

2.4. 'Science' and 'Society'

The relationship between science and society is complicated and constantly shifting (see Shapin 1985). The idealised vision of this relationship laid down by Merton (1942) and Bush (1945) stressed the autonomy of scientists to pursue 'basic' or fundamental research. Nowotny et al's later revisions (2001) stressed internal divisions in the production of scholarly knowledge by placing a greater focus on the applications of research. Despite these revisions - which place a emphasis on societal input in both determining the value of scientific undertakings, and in terms of attempting to guide the direction and outcomes of scientific research - science has nonetheless retained one consistent and core tenant of its autonomy. 'Good science' remains a judgement determined by other scientists, rather than by laypersons. And it is this inability for laypersons to contribute meaningfully to the determination of good science that is a hallmark of the division of science and society. Despite the inaccessibility of much scientific knowledge to laypersons, the centrality of science to society means that it matters to understand how the notion of science is being deployed and to what ends (see Gieryn 1983). In particular, it is necessary to recognise how science is often conceived of in post ideological terms, with the consequence that scientists can move beyond the suggestion of ideological distortion through reference to the notion of scientific 'truth' (p783). While the literature might recognise the contingency and spatial specificity of knowledge production (see Ezrahi 2004; Rheinberger 1997; Shapin & Schaffer 1985), the effect of these ideals in helping to create a powerful vocabulary for an ideological description of science (Gieryn 1983, p783) remains a central concern for this thesis.

2.4.1. Science, Society, and the Spaces in Between

Boundary work within the institutions of knowledge production constitutes of disciplines demarcating areas of academic territory, allocating the privileges and responsibilities of expertise, and structuring claims on resources (Gieryn 1983, p792). However, where scientists meet the public this boundary work instead consists of the ideological work performed by scientists to create a public image for science by contrasting it favourably to non-scientific intellectual and technical activities. The definition of what gets to count as science is open to reconfiguration depending on the context in which it is being applied. As a general rule, it consists of science both assuming a better explanatory power over the world, alongside a closer relationship to the 'real' world than other forms of knowledge can claim (see Lessl 1996, p382). These respective claims to epistemological and ontological superiority in turn help to inform an ideology of 'scientism' that reinforces the role of science in two ways. Firstly it affords scientific culture a kind of immunity from the kind of introspective scepticism that might undermine its own presupposition towards rationality (ibid). Thus, the ontological conflict between the scientific values of scepticism and rationalism is resolved ideologically through the belief that science is not driven by ideology in any case, and that its rationality derives from the real world. As a result, science need not admit itself to the authority of philosophy as there would be nothing to learn if it did. Secondly, this ideology maintains science at the centre of society because it means that it is only other scientists who are qualified to question science. In this sense, the demarcation between science and society is not reducible to an analytic problem. Rather the performance of boundary work matters precisely because of the considerable "material opportunities and professional advantages available only to 'scientists,'" and maintained by the authority that scientists alone are qualified to judge (Gieryn 1983, p781).

While certain institutions might have created a powerful aura around the idea of science, Allan Pred (1967) reminds us that it is people who man those institutions. Individual scientists may be partially driven by ideological commitments to science and

the hope science might hold for society, but they are also individuals working to secure careers and raise the quality of their own lives (also Lievrouw 1990). In the process the individual scientist must negotiate this complex relationship between the 'scientific good' (Taloy 1996; Barber 1987), their own status (Hessels et al 2009), their home lives, and any broader ambitions they may hold. If anything, the professionalisation of the sciences created a shift in which scientific practitioners increasingly came to view their work as a job, more so than as a calling or act of civic responsibility (see Shapin 2008). Therefore we can recognise motivations beyond the pursuit of knowledge have an influence in the production and trajectory of knowledge. Further, as Susan Owens (2000) argues, 'the public' is best understood as a relational attribute, determined by the level of alienation from dominant political and knowledge regimes in particular contexts (also Wynne 1998). By most measures this makes scientists a part of the lay public when they step outside the tramlines - however loosely defined - of their own discipline. Crucially, this suggests that the delineation of a public is inseparable from the motives of those claiming that the public must be engaged (Owens 2000, p1141). Finally, the idea of a distinct asocial model of science becomes particularly problematic when science communication relies on what is called a 'deficit model' (see Yearley 2005), by which a non-scientific lay public is assumed to be deficient in its understanding of the science issue at hand. Where this assumption is made the obvious solution is to increase the flow of 'good' information from science into society. Viewed through such a lens public misunderstanding and distrust of science simply represents a kind of distortion to be overcome; a distracting haze that can be cut through with a clear signal (see Barber 1987). And yet, this simplistic approach masks deeper questions like where it is that specific expertise emerges from and what is at stake in its application. When pursued on the assumption of a deficit of understanding, the dissemination of findings is simply another act of demarcation between the world of science and the world of non-science that maintains the prestige of science to continue making such interventions (see Lievrouw 1990).

Not all scientific findings have an immediate or particularly obvious relevance to society (Bornmann 2012). And certainly, it is not the case that all scientific findings have the

possibility of arousing much in the way of broader social or media interest. The kinds of scientific findings that do make the transition from concept to buzzword tend to already be attached to some broader issue of social significance, to which they provide an additional point of interest. A superficially similar example to this thesis' interest in the Anthropocene controversy is the Cold Fusion controversy. Cold fusion came to prominence in 1989 after two researchers sidestepped the usual process of peer review to disseminate their findings via a televised press conference at the University of Utah. As the controversy played out this inversion of the scientific process - with the media-facing public announcement of findings occurring before the 'normal' process of scientific peer review could be completed - took on its own significance (see Taylor 1996). But the large scale media interest in this announcement can also be understood by recognising how the project leads' novel claims affixed themselves to an existing and culturally resonant set of frames - fears about energy security, and the longstanding promise of extremely cheap energy produced by nuclear fusion - whilst creating a new set of narrative hooks in the form of a battle about the relative domains of jurisdiction for electrochemistry and physics. Whilst the science of fusion was not understood by the public at large, it was nonetheless broadly comprehended as a topic of heightened scientific interest, and the metaphoric deployment of 'cold' illustrated in an accessible way a powerful sense of how different these new findings were to existing thinking about fusion (Lievrouw 1990, pp 6-7). What is more, the possibility that cold fusion might challenge, contest, or otherwise upset the 'status quo' provided added value by creating new narrative possibilities for media discourse. Conflict, or the appearance of conflict, fit into the regular cycle of news reportage and provided a saleable 'issue package' (ibid).

As the cold fusion controversy developed, this media interest helped to drive external interest in the phenomenon in question in two ways. Firstly, whilst media attention was not necessarily efficacious in terms of telling scholars what to think about the cold fusion claims, it was extremely effective in terms of diverting attention towards dealing with those claims (Lewenstein 1992, p154). Secondly, media attention and the ways in which partial snippets of information were made public had the effect of enhancing the levels

of confusion about the fundamental science claims in play. New information came out at a rapid pace, and in keeping with the media interest, the information was not subject to peer review before being printed. In this way the media helped to enhance and sustain the controversy by complicating the diffusion tracks on which competing claims could travel (Lewenstein 1995a, p427). Mirth was not directed at the electrochemists Pons and Fleischman for instigating a scientific controversy, as the production of novel findings could be treated as an important curiosity. Rather, by going public through the media Pons and Fleischman were seen to be leveraging their presumed findings into forms of material gain like greater funding, and the wholesale reorientation of chemistry's subordinated position to physics. Other chemists that joined the fray were understood to be 'labouring' to make the novel chemistry that was being offered up 'acceptable' (ibid). That is, physicists understood the interest of chemists to be biased by the desire to enhance the visibility of electrochemistry, and recognised that these findings - if they could be confirmed - presented chemists an opportunity to promote their discipline.

But, even as extensive media interest sustained the controversy, that same heightened interest hastened the search for stability by creating the necessary conditions in which resources were mobilised towards resolving the problem at hand (Lewenstein 1995a, p429). This raises the problematic spectre that media interest was understood by scientists as a proxy for discerning the social interest or societal value in the outcomes of the research, where a more level analysis might suggest that the media's interest was in the far more prosaic act of shifting copy (Lewenstein 1992, p153). Perhaps more importantly given the increasing influence of the web, the cold fusion controversy also demonstrated the point at which media and new, rapid forms of communication started to admingle in ways that we have not yet fully accounted for (also Taylor 1996; Lewenstein 1995b). The landscape for science collaboration and communication was shifting with the introduction of internet message boards that allowed for the near instantaneous dissemination of findings and articulation of putative results. Latterly, quasi-academic reportage websites like *The Conversation* have helped to normalise these interstitial spaces between mass media and peer review where scientists can

sound out ideas prior to consolidating them in more formalised writing. Therefore, the challenge with cold fusion was not only an increase in the quantity of material in absolute terms, but also a mismatch in terms of timings. The vouchsafe of the peer review system did not apply to certain channels in which information was being disseminated, which meant that opinions and arguments could appear on an expedited turnaround time. This helped to create a situation in which the information available was highly unstable, with accurate and less accurate information moving around at a rapid pace. Amidst the noise it was increasingly difficult to contextualise the judgements being made in the production of any knowledge claim and the motivations behind the various rhetorics in play.

In all this the media could switch between active and passive roles; playing on this conflict for public positionality and actively shaping the character of the debate. Indeed, it suited the media playbook for framing newsworthy items to favour the novel insurgency of the electrochemists. Their presumed findings were both legitimately exciting in terms of their potential application, and they simultaneously pushed against a perceived status quo in exciting ways (Lewenstein 1992, p156). But this decision to offer a kind of tacit support to Pons and Fleischman's claims - alongside the very conspicuous arena in which this controversy came to play out - had large implications for the character of the debate that followed. The result was a context that favoured extremely strong vocalisations of position. In order to rise above the din, to be seen, and to be heard, those who involved themselves in the public controversy over cold fusion had to project their opinions in the strongest and most authoritative terms available to them (Lewenstein 1995a, p430). In this unstable context both sides clung to the idea that a clear signal - the correct science - could be projected above and beyond the white noise of debate. Ultimately the anomalous nature of the cold fusion findings were established through the peer review system, reaffirming the superior authority of physics, and allowing for the role the media had in shaping the conditions of the controversy to be written out of the story.⁴ The disciplinary visibility of chemistry was no

⁴ Where it not for the work of a number of scholars who have taken interest in the cold fusion controversy it would simply be that Pons and Fleishman were wrong.

longer meaningfully at stake, and physics no longer faced a crisis of competence over its assumed domain of expertise. Absent these specific motivators for disciplinary self-interest there was far less reason in maintaining conflict, and without which there was no story for the media (McAllister 1992, p44). The science of cold fusion was pushed to the fringe, and proponents of the idea found themselves unable to muster support from inside or outside the academy.

2.4.2. Knowledge in the World, and ‘Outformations’

The value of the cold fusion saga is that it illustrates the difficulty of constructing a neat and clear narrative to the production of knowledge before and after it becomes popularised. In the cold fusion controversy there was no obviously internal and obviously external discourse to science (see Taylor 1996). Instead, the controversy revealed multiple discursive spheres connected by complex feedback loops. In the thirty years that have passed since the cold fusion saga the context into which knowledge claims are presented has only grown more complicated. The increase in bulk information and the confusion generated by a proliferation of communication channels has helped to enhance the desire to project findings with clarity. And further, as scientists have been left unable to maintain a complete expertise even within their own fields (Shapin 2010, 387), the complexity of modern science and the increasing specialisation required of practising scientists has even given rise to new roles. For example, ‘knowledge brokers’ have emerged as an increasingly important professional class that sits in the space between the producers of science and the intended audience for findings (see Meyer 2010; also Lyall et al 2015b). The broker’s job is to chop through the thicket and deliver the results of science to society, or at least convince society of the value of scientific work. This act of brokerage entails more than simply moving knowledge. Rather, it is better understood as an act of translation designed to coordinate perspectives, align aims, and facilitate further informational exchange. According to Meyer, the rise of the broker illustrates two things. Firstly, that disinterest no longer equates to rigour (2010, p119). Instead, the post-war settlement that imagined the good scientist as essentially invisible has given way to a scenario in which science

must be promoted as much as it is proven (see also Lievrouw 1990). With complex environmental issues defined by the threats they pose society - of which the Anthropocene seems emblematic - it is the very fact that the findings should matter to the public at large that drives a moral imperative to convey findings with clarity. And secondly, that despite the growing pressure for science to speak to society, the distinction between these two domains is institutionally maintained (see also Shapin 2010, p388). That is, the very presence of knowledge brokers who are brought on board to do the hard work of cutting across disciplines helps to sustain the supposed divides between those disciplines rather than resolve them.

Despite a broad pressure on sweeping reconfiguration, the relationship between science and society remains largely unidirectional. Science creates information on which society might be expected to act. Where the consequences of disregarding this information might be considered dangerous, society must act on that information or disregard it at its peril. This model is all well and good assuming that science maintains a purely neutral and advisory role on the issues that might be said to affect society. However, as I have argued, science is a social enterprise that can never fully absolve itself of the political implications of 'worlding'. It takes years of training, expertise, and guidance in the specific disciplinary norms of a particular knowledge domain, alongside extensive material resources to make accurate knowledge claims about something as complex and abstract as, say, the climate. As a result, it is not an act of denigration to view science as an exclusionary practice but rather a statement of fact. Nonetheless, we can recognise how the 'science wars' has rendered this critique of science - one recognises the social construction and (at least) partial contingency of all knowledge - visible. As the 'science wars' became a public phenomenon, and despite notorious attempts to humiliate the suite of postmodern humanities (for example Sokal 1996a; 1996b), the effect has been to mainstream the possibility that the authority of science to speak on and for certain matters is not absolute (see Bornmann 2013; Fontana 2001). This all contributes to an on-going 'crisis of representation' (see Shapin & Schaffer 1985), in which the mobilisation of expertise has become increasingly challenging even

as the desire to lean into something solid has become ever more acute (Shapin 2010, p388).

As the visible impact of science in society has grown (see Ezrahi 2004; Taylor 1996) so too have its unintended consequences been rendered more apparent to society (Latour 2012). Nonetheless, modern science has been slow to recognise its own role in the production of modern risks (see Shapin 2010, p380; Beck 1988). So, whilst Demeritt (1996) notes that science is hopelessly and perhaps unfairly trapped between being the cause and saviour of the modern world's problems, I think we ought to take seriously the risks of doubling down on the argument in favour of science's unique epistemic privilege whilst the trust in that authority to speak for any given phenomenon remains a point of tension. At the same time - recognising that anti-intellectualism in political and public life is no new thing (Hofstadter 1966; also Asimov 1980) - our contemporary moment seems to represent a point in which public confidence in science, and indeed all forms of authority appear to be at an unprecedented low.⁵ This "patina of distrust" (Owens 2000, p1142) covers the positivity bias in academic publishing, and the way this skews in favour of 'profound' arguments regardless of their rigour (see Smaldino & McElreath 2016; Devlin 2016), to questions about the overuse of quantitative measures like statistical significance as a determinant of proof (Colquhoun 2016). This crisis also extends into more overtly political arenas in ways that have bearing for the application of specialist expertise. After the financial crisis popular trust in economics appears to be at an all time low (Mallaby 2016; Ferguson 2010). The polling fiascos of both Brexit and Trump (Chalabi 2016), and the worrying precedent that 'fake news' disseminated through social media might play in determining the outcomes of political elections (in Solon 2016; also Carroll 2016) all have implications for the trustworthiness of expertise. Former British Justice Secretary Michael Gove's confident and smug assertion in support of wilful ignorance - by suggesting that "people [in the UK] have had enough of experts" (in Mance 2016) - appears in hindsight to be an astute summation of this contemporary milieu. What hope, then, for environmental science in this context?

⁵ Bernard Barber (1987, p131) suggests that this crisis is longer standing than I suggest here. However, as with interdisciplinarity I would argue that it is the ideology and the narrative of crisis that matter than their 'reality'. As long as institutions act as if the crisis is immediate then that crisis is eminently 'real'.

This is a context that also provides little recourse for the average member of the public to assess the validity of claims thrust upon them (Taylor 1996, p128). They need not necessarily understand the science, but they need some sense of where to look for it, and of who holds relevant expertise (Shapin 2010, p387). For the 'big issues' - those scientifically complex problems with extensive political implications - like nuclear energy, GM crops, and climate change this relationship comes under increasing tension as the multiple sources which might offer contradictory positions are drawn into dialogue and sometimes conflict. These are the very issues whose complexity is said to require a 'transdisciplinary' blending of perspectives and insight (Lang et al 2012, p26). Yet, rather than open discussion up to account for a plurality of viewpoints, scientists have increasingly used the imprimatur of scientific authority to conjure nightmarish and apocalyptic imagery to hammer home the nature of profoundly dangerous but often abstract risks (Masco 2010, p9; Hulme 2009, p333; pp 345-348; Yusoff & Gabrys 2011). For political geographer Erik Swyngedouw (2010) this context creates a flash point at which climate change - to which we can broadly affix the Anthropocene as an extension of similar scientific and narrative tropes - collides problematically with the project of open, democratic politics. Issues like climate change become mainstreamed through the populist and universalist appeal of their crisis status. In Swyngedouw's view, at the same moment that an issue like the climate enters the public consciousness and 'becomes political', the possibility of democratic political action on climate change is undercut by the dizzying sense of urgency at play (also Agamben 2005). Political theorist Yaron Ezrahi (2004) sees this shift as one from 'information' to 'outformation', where outformation is the final stop in a degradation from situated knowledge(s) - delivered alongside the context of production - towards information - which is delivered without context. For Ezrahi, Information - despite its superficial character - is nonetheless socially inclusive and mobile:

Unlike the knowledgeable, the merely informed need not make heavy investment in learning. One need not be judicious, wise, inspired or technically sophisticated. Still one must be able to process information.

Information is often specifically designed or directed to be used for a purpose.

(Ezrahi 2004, p258)

While information might be deployed to cynical ends, outformation represents one further step, divorcing information from any visible agent. In this sense, outformation exists as a texturally rich emotive gloss, and a vector for low cost of entry 'cheap' realities that are highly compatible with the modern political process. Instead of a densely organised system of "concepts, facts, clues, rules, interpretive codes, working metaphors, methodological skills, operations, evidence, claims and rhetoric" that is largely inaccessible to laypersons, outformation is rapidly transferable, seemingly inclusive, and requires little more than a minimal engagement from citizens (p262). Outformation might appear more independent and open than the knowledge produced by scientists, but the lack of context and focus on emotive appeal and provocation make outformation a particularly effective way of concealing bias. Well intended or not, the culture of outformation rests precisely on the fact that claims do not rely on any independent reality against which to check them, creating a much more ambiguous relationship between the world and its representations (p268). Ezrahi's critique was directed - quite pointedly - at the kinds of messaging that emerged from the right wing US administrations of Reagan through to Bush Jr. and its role in reducing complex geopolitical situations into jingoistic bombast. Nonetheless, the danger is that beyond the good intentions with which it is communicated, in this new context - and set against the 'noise of distrust' (Yearley 2005) - scientific knowledge that projects itself with an outmoded and authoritative rhetoric of science risks becoming indistinguishable from outformation.

2.5. Conclusion

If the above helps to set a context for making sense of the Anthropocene controversy, it is equally important to explore how the Anthropocene held together in spite of this messiness. The validity of claims mattered in part because the conditions under which

the concept could be understood as valid shifted as this epistemic thing moved across disciplinary lines. Disciplinarity mattered to the Anthropocene in part because different epistemologies did not simply produce different insights into the phenomenon, but fundamentally altered the stakes in its deployment. Terminology and rhetoric mattered in part, because it was the ability of the Anthropocene terminology to provoke certain responses that meant this new knowledge claim could have an impact on society. And, as I have argued above, it was the contemporary dynamics at play in the relationship between science and society that made it so important for scientists to seek to establish the validity of the Anthropocene. This was a complex stage for new knowledge to emerge onto, and I want to be clear that this inherent messiness does not equate to 'bad science'. The Anthropocene controversy did not represent a violation of the fiduciary trust that society places in science or scientists (see Barber 1987). Quite the contrary, the Anthropocene concept sits in the complicated space between a contested scientific observation and an uncertain political intervention. It is quite right that such a concept should provoke debate, and it reveals only the challenge for scientists and scholars whose work draws them up against long standing challenges including the hierarchical privileging of certain kinds of knowledge over others and the ways in which scholars can make their work both known to, and recognisably useful for society. Against a backdrop of falling public trust in authority and the disavowal of expertise, this messiness is in part a consequence of scientists and scholars recognising that terms are never neutral, but sometimes acting as if they could be when visibility, credibility, epistemic status, and funding are on the line.

Chapter 3: Methodology and Ethics

3.1. Introduction

This chapter is split into two broad sections. The first section outlines the specifics of my methodology, while the second outlines a number of methodological considerations important to this thesis. In my exploration of the Anthropocene controversy I performed a detailed analysis of arguments and discourse that played out across a broad range of literatures, and matched this work by engaging directly with a number of key interlocutors in the controversy. As explored in the literature review, this thesis attempts to grapple with what is at stake for various interlocutors in the Anthropocene controversy and what they hoped to achieve with their engagement (see Mol 1999, p74). As a result my approach focused on recognising the situatedness and context of the interventions made by those participating in the controversy, alongside the implications of their arguments for the controversy as a whole (see Barad 1999; Law 2002; Latour 1988). The second section of this chapter considers the partiality of, and the ethics of this research. There are two reasons for such a detailed consideration of these dynamics in this instance. Firstly, following John Law (2004) I am sceptical of research methodologies that process the often-fragmentary ‘mess’ of research into something distant, hygienic and sterile (also Dey 2007; McDowell 1998). Secondly, in my view the Anthropocene controversy had much to do with misunderstandings between scholars who did not understand the ways in which others engage with a nominally shared interest. As a result, I believe it is essential for a researcher such as myself to be mindful of the capacity to exacerbate the very controversy I had placed under investigation. Following this recognition, the ethical considerations of this thesis related to both the treatment of subjects in the interview space, but also to the politics of representation. In this view, even the negotiation of access constituted an on-going ethical entanglement between the need to respect the standpoints of participants, and the desire to gather useful information.

3.2. Approach

In this research I analysed scholarly literature on the Anthropocene, and complemented this with further analysis of interviews, surveys, and email correspondence with the authors of these materials. The relationship between these two techniques was mutually strengthening (Latour 1999), with interviews, surveys, and email correspondence generating further insight into the scientific arguments present in the literature (Gilbert & Mulkay 1984). In total this thesis considers 539 discrete artifacts. This total consists of 385 peer reviewed and scholarly materials, 72 journalistic and popular materials, 39 semi-structured interviews, 19 open-ended surveys, 13 email correspondences with participants, and 11 additional miscellaneous materials.

3.2.1. Analysis of Anthropocene Literatures

My analysis began with the selection of appropriate materials. Paul Crutzen's original two papers on the Anthropocene (Crutzen & Stoermer 2000; Crutzen 2002) served as a nexus for the Anthropocene controversy, with the vast majority of subsequent papers referring to one or the other in some way. I used these two articles as an entry into the controversy, and as a point from which to trace the vast network of publications, authors, and institutions involved in Anthropocene-related scholarship (see Latour & Woolgar 1986; also Latour 1987). I paid particular attention to the efforts of the Anthropocene Working Group (AWG) and its members, taking account of their crucial role in shaping the literature both in terms of the specific stratigraphic controversy around the Anthropocene, and the broader influence their publications had in fomenting debate. Exploring the perspectives and disciplinary allegiances of members allowed me to understand how members contributed to the making of Anthropocene claims and illustrated their interests in the controversy. As the controversy was consolidated through the formation of Anthropocene-centred journals these too became essential points of reference in the controversy and were granted special attention. The period under investigation in this thesis begins with Paul Crutzen's Cuernavaca outburst in February 2000 and continues until late 2016. This end date allowed me to account for

two important events, namely, the explosion of media interest in the Anthropocene surrounding the 35th International Geological Congress in Cape Town at the end of 2016, and a critical intervention in the journal *Nature* launched by AWG member Erle Ellis in December 2016 in which he publically staked out a position that broadly opposed the role and function of the AWG as it had existed until that time.

This window covers the period in which the argument for a stratigraphically ‘real’ Anthropocene was consolidated by the AWG. After this period the AWG began to explore possible ‘golden spike’ locations and transitioned towards the production of a formal proposal. This transition will doubtless create a new set of materials and could provide an interesting subject for analysis at a later date, but as of the completion of this thesis did not yet constitute a substantial or coherent body in and of itself. A few pieces of the material analysed herein do fall outside of the dates given above. I used this material either for the influence that it later exerted on the Anthropocene controversy, or because it represented a clear continuation of other arguments in the controversy and could not be ignored.⁶ In total I analysed 385 peer reviewed and scholarly materials in this way, a total that includes material published in scholarly spaces but was not itself subject to peer review. I complemented this literature with analysis of 72 journalistic and popular materials, which allowed me to trace the spread of the Anthropocene beyond a purely academic debate and consider how academic and non-academic literatures reverberated through one another. I also analysed 11 miscellaneous materials including the AWG’s annual newsletters, a widely circulated petition against the Anthropocene, and the retiral performance of one AWG member because each illustrated important dimensions in the controversy. For a more complete breakdown of the sources of these materials, please refer to Table 1.

Identification of sources was largely performed using Thomson Reuter’s Web of Science as writing on the Anthropocene largely consisted of scholarly articles and

⁶ These are Lovelock (1979), Emiliani (1993), Redman (1999), Samways (1999), Schellnhuber (1999), Angus (2017), Brown et al (2017), Edwards et al (2017), Castree (2017a; 2017b), Farrier (2017), Holmes et al (2017), Latour (2017), Raworth (2017), Zalasiewicz & Jin (2017), and Zalasiewicz et al (2017a; 2017b).

academic texts. However, the rapid spread of the Anthropocene meant that it was also being expounded in non-academic media as well for a variety of reasons. Mapping the field gave a sense of the dimensions of the controversy, and allowed me to take account of both disciplinary allegiances and boundaries (see Gieryn 1999), and the ways in which different groups of scholars were trading ideas about the concept (see Galison 1997; Galison 1999; Collins et al 2010). The literature that was identified in this way formed the basis of my analysis, as it served as the primary vehicle through which the Anthropocene was formed, debated, made to move, and given validity and meaning (see Atkinson & Coffey 1997; Prior 1997). Crucially, I set deliberately loose parameters on what constituted an intervention in the 'Anthropocene' controversy. Following Charles Alan Taylor I sought to "problematise the unreflective distinctions often drawn between the internal and external discourses about science" and avoid labelling "particular discourses, a priori, as intrinsically scientific or non-scientific" and thus ignore their reciprocal influences (1996, p179). Because my interest lay in tracing the movement of the Anthropocene concept across disciplines, I did not seek to specify returns by their disciplinary status. And, I was similarly agnostic to the extent to which interventions - whether in the form of journal articles or book chapters - forwarded 'new' claims about the Anthropocene. It was precisely the question of what different groups sought to do with the Anthropocene concept that motivated my study. In this sense the scientific arguments for and against the Anthropocene constituted only one, albeit critical, space in which the controversy played out. Elsewhere, the adoption of the Anthropocene under terms of reference unfamiliar to stratigraphy and discussed using an expressly non-scientific language were equally important in terms of their contribution to the Anthropocene as a phenomenon in academic publishing. Using these resources provided an opening to ever-growing space for debates around the Anthropocene, its meaning, its role, and its scientific value (see Collins 1975). Chasing citations also allowed me to find out what sources the authors were mobilising in support of their claims. For example, a large amount of overlap in terms of the sources mobilised by different groups could imply different interpretations of data, while mutually exclusive datasets could express fundamentally different approaches to the question of the Anthropocene.

Given the importance of the stratigraphic controversy about the Anthropocene I was exhaustive in my analysis of literature produced by the AWG and its members, and geoscientific responses to that work. I was similarly exhaustive in my engagement with work in the social sciences that sought to actively reshape the Anthropocene discourse. Beyond this, it was important to recognise some practical limitations. As of January 2017, a Google search for 'Anthropocene' yielded 1,480,000 results. This number has only grown since, and Eduardo Brondizio and co-authors (Brondizio et al 2016) note both a year-on-year exponential increase in the number of articles that employ the term 'Anthropocene' in "the title, abstract or text body," and the exponential increase in the number of citations that these articles receive (p320). As the term continues to proliferate and becomes something closer to an accepted 'fact' in certain communities, it becomes increasingly difficult to keep track of its appearances. It is perhaps the case that these communities have stabilised a coherent enough set of meanings for the Anthropocene that it has slipped into the background as a necessary context for further work, and thus no longer warrants specific discussion. In that sense, the Anthropocene has already begun to fade into the background as the epistemic wallpaper for a whole set of new claims. Recognising the overwhelming volume of this more expansive material, I made use of purposive sampling of texts with particular or interesting stakes in their adoption of the Anthropocene (see Silverman 2005; Valentine 2001). Following Thomas and Myers (2015), my aim was not to account for every piece of literature to evoke the Anthropocene in some way, but simply to cover enough of the available published materials to be able to give a meaningful sense of the arguments, motivations, justifications, and tensions involved in engaging with the Anthropocene controversy.

My analysis drew from the three stages of the empirical programme of relativism in the sociology of scientific knowledge. In particular, I wanted to demonstrate the openness and interpretative flexibility of the arguments made for the various versions of the Anthropocene. I wanted to explore the social processes that facilitated the closing of debate within the scholarly communities involved. And, I wanted to investigate how

these processes intersected with social forces beyond the scholarly communities involved (see Collins 1981b; 1981a; Collins & Evans 2002). My concern here was with the reception of ideas in the Anthropocene controversy. At no point do I discuss the physical reality of the changes that the Anthropocene label was said to represent, and nor do I question them. Nonetheless, my argument follows that the reality of the Anthropocene was contingent upon the differing representational strategies of various scholarly disciplines and kinds of epistemic practice. Of particular interest here is the role of social processes in closing the Anthropocene controversy and the precise form of that closure. For the Anthropocene, the empirical programme of relativism's major contribution - the recognition that controversies are resolved due to the parties involved agreeing or being forced to stop disagreeing and not because of some incontrovertible piece of natural evidence (see also Bloor 1991) - has been explicit from the moment that the concept was first considered in formal stratigraphic terms. Changes to the International Chronostratigraphic Chart are subject to a democratic voting process and ascension is confirmed by the support of a 60% supermajority of eligible voting members within the commissions that make up the institutional machinery of the discipline (see Salvador 1994). However, that there exists a formal accounting structure within stratigraphy to deliberate over revisions to the International Chronostratigraphic Chart and its nomenclature provides a locus for the Anthropocene controversy. In particular, the applicability of that very accounting structure to the question of the Anthropocene - where the changes that label were said to represent were otherwise known - was the subject of implicit and explicit discussion throughout the literature. The Anthropocene is a particularly valuable example in this sense because the relationship between internal debates and the social forces beyond the scholarly communities directly affected by this epistemic thing (stages 2 and 3 of the empirical programme of relativism) was recognised by interlocutors: part of the argument for and against the Anthropocene related to the question of what the concept might achieve for communities downstream and the longer term implications it might have for the scholarly communities involved to pronounce upon it in certain ways. Despite the success of the empirical programme of relativism in suggesting the way in which society, not nature, has final sway over the success or failure of scientific claims, work

that has meaningfully explored how broader social forces intervene in the settlement of controversies has been in short supply (see Yearley 2005, p33; also Collins & Pinch 1993).

Following Ian Dey (1993) I employed a range of analytic techniques to explore the social dimensions of the controversy. In particular I make use of the analysis of scientific discourse (ASD) to discern the ways in which authority was given and maintained in Anthropocene literatures (see Gilbert & Mulkay 1984; Latour & Woolgar 1986; Dittmer 2010; Hepburn & Potter 2007). ASD explores the discourse used in scientific texts and seeks to describe how scientific accounts are organised to portray actions and beliefs. In keeping with the position outlined in the literature review I treated scientific discourse primarily as an ideological rhetoric of demarcation (see Taylor 1996; Gieryn 1983) that can only be understood against a broader social context. This position assumes that in scientific writing researchers deploy rhetorics like the norms of science as a 'professional ideology' to defend their intellectual freedom. This, in turn, helps to create a framing that demarcates science from non-science, to which scientists can then attach external significance (see Mulkay 1976). Therefore, ASD is about decoding the argumentative strategies that scientists mobilise in any given situation. Not necessarily as a coherent discourse - as originally envisioned by Nigel Gilbert and Michael Mulkay (1984) - but as a revolving toolset (see Yearley 2005, p96). In following this strategy I went through a processes of sampling information from the text, establishing trends, operationalising these findings and applying them to a broader set of materials. Initial readings of texts were generally unstructured, and it was as a consequence of familiarising myself with the material that I was able to start drawing together patterns and establish a coding system that would allow me to systematically relate materials together (see Dey 2007; Kitchen & Tate 2000; Corbin & Strauss 1990). The form and intended audience of arguments also have important consequences for both their accessibility, and their likelihood of convincing particular audiences (see Atkinson & Coffey 1997). And, by considering the ways in which arguments were cited and enrolled in later works I could analyse how groups constructed a network of allies to make claims

move (see Latour 1987; Callon 1986). Looking at texts this way rendered them as active objects that structure and organise thinking (see Rapley 2007; Watson 1997).

385x peer reviewed and scholarly materials

Defined as: traditional journal articles, books, book chapters, and edited volumes.

Including materials published by the AWG in the following journals:

AMBIO: A Journal of the Human Environment, Anthropocene, The Anthropocene Review, Bulletin of the Atomic Scientists, Carbon Balance and Management, Climate Change, Climatic Change, Earth's Future, Earth System Dynamics Discussions, Environmental Science & Technology, The European Archaeologist, Geology, Global Environmental Change, GSA Today, IGBP Global Change, Nature Geoscience, Science, Science in Parliament, Quaternary International, Transactions of the American Geophysical Union, and Wiley Interdisciplinary Reviews.

Special edition publications, edited volumes, and books (by both AWG members and non-members):

The Anthropocene and the Global Environmental Crisis, Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism, The Birth of the Anthropocene, Cultural Anthropology, Earth System Science in the Anthropocene: Emerging Issues and Problems, Environmental Humanities, Environment and Society: Advances in Research, Geological Society of London Special Publication, Geographical Research, The Oxford Literary Review, Philosophical Transactions of the Royal Society of London, Rendiconti Lincei, The Shock of the Anthropocene.

'Technically' motivated interventions in the journals:

21st Century Science and Technology, American Journal of Science, Annual Review of Earth and Planetary Sciences, Anthropocene, The Anthropocene Review, Atmospheric Chemistry and Physics, Biogeosciences, Biological Theory, Climate Change, Current Anthropology, Earth Surface Processes and Landforms, Ecology, Environmental Chemistry, Environment: Science and Policy, Environmental Science & Technology, Geophysical Research Letters, Global Ecology and Biogeography, Global Environmental Change, GSA Today, The Holocene, Journal of Biogeography, Journal of Insect Conservation, Journal of Quaternary Science, Marine Geology, Nature, PLoS ONE, Proceedings of the National Academy of Sciences of the United States of America, Quaternary Australasia, Quaternary Science Reviews, and Review of Geophysics.

'Politically' motivated interventions in the journals:

Alternatives: Global, Local, Political, Annals of the Association of American Geographers, Annual Review of Anthropology, Antipode, Antiquity, Anthropocene, The Anthropocene Review, Capitalism Nature Socialism, Critical Inquiry, Dialogues in Human Geography, Ecology and Society, Environment and Planning D: Society and Space, Environmental Values, Ethics, Policy & the Environment, European Journal of Social Theory, Futures, Geo: Geography and Environment, Geoforum, GeoHumanities, Geography Compass, Gender, Place & Culture, Global Applied Ethics, Global Environmental Change, Global Policy, History

<p><i>Compass, Journal of Contemporary Archaeology, Journal of the Royal Anthropological Institute, New Literary History, Platypus Review, Progress in Human Geography, Social and Cultural Geography, The Sociological Review, Social Studies of Science, Transactions of the Institute of British Geographers, and Telos.</i></p>
<p>72x journalistic and popular materials Defined as: press releases, mainstream journalistic sources, materials from blogs (written by scholarly interlocutors in the debate), more informal blogs, and materials pitched at interested but non-specialist audiences</p>
<p>Including:</p> <p><i>Mainstream news on the Anthropocene on the BBC (website, TV, and radio), in Der Spiegel, The Guardian, The Independent, The Observer, The New York Times, and The Telegraph.</i></p> <p><i>Special interest news in Anthropocene Magazine, The Economist, National Geographic, Nature, Science, and TIME.</i></p> <p><i>Think pieces and commentaries by interlocutors in the controversy on publicly accessible websites like AEON, and The Conversation, and Huffington Post.</i></p> <p><i>Science blogs EOS, IEEE Spectrum, and Physics Today, and the Institutional blogs of the Breakthrough Institute, Future Earth, and the STEPS Centre.</i></p> <p><i>Popular Science writing and TED talks.</i></p> <p><i>Press releases from the University of Leicester, California State University Long Beach, and The Fridtjof Nansens Institutt</i></p>
<p>11x miscellaneous materials Defined as: materials outwith the above categories that nonetheless provided useful insight into the activities and thinking of the AWG, or illustrated other dynamics in the controversy</p>
<p>Including:</p> <p><i>The AWG's letter to potential new recruits, 6 AWG (yearly) newsletters, a retiral 'performance piece' by an AWG member, a petition to the International Commission on Stratigraphy arguing against Anthropocene formalisation, and a mass circulated email encouraging people to sign the above.</i></p>

Table 1: Simplified breakdown of peer reviewed and scholarly materials, journalistic and popular materials, and miscellaneous materials used in my analysis of the Anthropocene controversy. Table illustrates the range of disciplines engaged in the Anthropocene controversy and the number of spaces across which interlocutors made arguments about the Anthropocene. The range of journals in particular helps to illustrate the extensivity of the Anthropocene controversy. Interviews, surveys and email correspondences are dealt with separately in Table 2.

3.2.2. Interview, Survey, and Email Correspondence

In addition to my analysis of Anthropocene literatures I performed analysis on 39 interviews, 19 surveys,⁷ and 13 pieces of email correspondence with participants who were otherwise unavailable for interview or to whom I continued to pose follow-up questions after my interview had ended. In total I spoke to 55 participants in this way, sometimes taking advantage of multiple of the above methods. For example, 12 AWG members consented to a full interview upon returning a completed survey, which presented me with the opportunity to analyse their responses prior to interview, and then dive more deeply into their responses, their views, and their understanding of their role in the Anthropocene controversy. Of my total, I drew 19 participants from the AWG, whose efforts played a central role in driving and shaping the Anthropocene controversy. Alongside these AWG members I performed interviews and email correspondence with 13 ‘technically’ motivated interlocutors in the controversy from the disciplines of archaeology, climate science, ecology, geology, geomorphology, pedology, physical geography, and Quaternary science, and 12 ‘politically’ motivated interlocutors in the controversy from the disciplines of anthropology, environmental science, environmental economics, environmental philosophy, human geography, neomaxist critique, and postcolonial studies. While I sampled my participants on the (coarse) nature of their engagement in the controversy, with those motivated over ‘technical’ concerns generally raising questions about the prospect of stratigraphic formalisation as the AWG presented it, and with those motivated over ‘political’ dimensions raising questions in the literature about the ‘meaning’ and ‘implications’ of the Anthropocene concept, in practice all participants engaged with the Anthropocene controversy in complex ways that cut across this presumed binary. Nonetheless, each of these participants actively helped to shape the dimensions of the controversy through

⁷ These surveys were produced as a necessary condition of access to the AWG, as discussed in Section 3.3.3. and were only issued to AWG members. A blank version of this survey is included in Appendix 1. The survey asked similar questions to those asked during interview and correspondence, and were processed in the same way as the other data collected. Surveys were open ended and participants were free to respond in as much detail as they saw fit. While one particular survey response frustrated me with single word answers to the majority of the questions, one respondent included 14 pages of material answering the questions in the survey. Where surveys served as a first step prior to interview they gave an opportunity to reflect on responses before asking a more detailed set of follow-up questions.

their engagement, either by advocating for the role that their particular disciplinary expertise could play in consolidating a better understanding of the Anthropocene phenomenon, or by promoting the adoption of the concept amongst their own disciplinary communities. Interviews with the editors of 2 of the 3 Anthropocene-centred journals provided a crucial perspective on the efforts to shape the controversy (and interest in it) into a productive shared discourse.

While the vast majority of participants were well established in their disciplines and leveraged that expertise in their arguments, a couple of the participants were early career researchers. Nonetheless, the motivations and rationale for these junior researchers to engage helped to illustrate broader institutional dynamics within the controversy. For example, one early career researcher that I spoke to had sought out the Anthropocene while preparing an article from their doctoral research for publication. Engagement with the Anthropocene - an active controversy - was at the time an effective route to enhancing that work's publishability. And, further engagement with the controversy had allowed them to publish far more than they might otherwise have been able to (1x survey). Another early career researcher appeared to adopt the Anthropocene in publications as a result of the institutional relationship they held to an AWG member through their doctoral supervisor despite themselves not being in the group (1x interview). While they played a lesser role in the final analysis, I also performed 8 interviews with the members of an 'Anthropocene'-named research cluster working on the detection and attribution of climate change as well as past and future climate variability within the earth sciences department of a major UK university. The inclusion of this group was in keeping with my desire - as outlined in the literature review - to situate the Anthropocene controversy within the broader dynamics of interdisciplinarity and societal accountability. While this last group was not engaged directly in the controversy (for example, by publishing papers arguing in support of the Anthropocene) they had sought to adopt the term, had an interesting set of motivations for doing so, and their involvement in this thesis allowed me to trace epistemic frictions inherent in the controversy beyond the more formal spaces in which the concept was being debated. This was an important ground-level view of the controversy and its

implications (for a more detailed breakdown of the participants see Table 2). While there were shared questions to ask of each participant, the interviews, surveys, and email correspondences were tailored to the specifics of the researcher whose work I was attempting to gain access to.

19x Anthropocene Working Group Members	13x 'technically' motivated interlocutors
<p>Including representatives of the disciplines of:</p> <p><i>Earth system science, sedimentology, palaeoclimatology, geomorphology, tephrochronology, geochemistry, atmospheric chemistry, landscape ecology, meteorology, petrology, tropical soil biology, oceanography, palaeobiology, archaeology and landscape archaeology, urban geoscience, environmental engineering, climate modelling, science and technology studies, the history of science, environmental history, environmental journalism, maritime law, and sustainability research.</i></p> <p>And with some members serving multiple institutional roles:</p> <p><i>One member who served a central role in the International Geosphere-Biosphere programme, and two members who serve additional roles within the International Commission on Stratigraphy.</i></p>	<p>Including representatives of the disciplines of:</p> <p><i>Archaeology, climate science, ecology, geology, geomorphology, pedology, physical geography, and Quaternary science.</i></p> <p>And including:</p> <p><i>A member of the Holocene Working Group and former member of the AWG</i></p>
	12x 'politically' motivated interlocutors
	<p>Including representatives of the disciplines of:</p> <p><i>Anthropology, environmental science, environmental economics, environmental philosophy, human geography, neomaxist critique, and postcolonial studies.</i></p> <p>And including:</p> <p><i>A curator from the Haus der Kulturen der Welt Anthropocene 'campus' that hosted the first meeting of the AWG, a journalist and populariser of the Anthropocene, and the Stockholm Resilience Centre and Future Earth communications director</i></p>
2x Anthropocene-centred journal editors	
<p>Including:</p> <p><i>One editor with institutional ties to the IGBP who was present at Cuernavaca meeting at which the Anthropocene was first coined.</i></p>	
8x 'Anthropocene'-named research group members	
<p>Including:</p> <p><i>Atmospheric chemists, atmospheric modellers, and physical geographers.</i></p>	

Table 2: Simplified schematic of primary data collection from 55 individual participants, illustrating their role within the controversy. For more detail - including both the method of engagement (whether interview, survey, email correspondence, or a combination of the above) - and institutional relationships (where some participants occupy multiple roles in the controversy) - please refer to Appendix 2.

According to Gilbert and Mulkay (1984), scientists make use of an 'empiricist' and a 'contingent' repertoire in describing their work. The empiricist repertoire - used in the publication of academic work - implies that all beliefs and actions derive from the natural world, are wholly rigorous and objective, and are uncomplicated by any kind of contingency (see also Burchell 2007). Thus, when we only read scientific accounts as they appear in scholarly literature there is an emphasis on formally constructed methods and impersonal rules. In this empiricist repertoire the individual character of the researcher has no bearing on the results that arise from scientific investigation, and the impression given is that rote replication can and should produce identical results. In reality, we know that exact replications are impossible, with researchers constantly competing to settle controversy through their own iterations on (sometimes extant) methods whilst operating at the limits of their observational and experimental abilities (see Collins 1975). By contrast, considering the contingent repertoire of scientists gives us a sense of how and why it is that scientists stabilise findings and produce consistency (Gilbert & Mulkay 1984). Thus, when we deal with formal accounts alone we miss out on the conversations that give findings weight and meaning for the researchers that produce them, and we risk taking scientists' accounts of their own work too seriously (see Yearley 2005). Thanks to their less formal and more retrospective character it is possible to gain a measure of greater access to the practical realities of scientific practice during interviews, survey, and email correspondence. In each instance the participant tends to be reflecting statements expressed elsewhere rather than attempting to justify or forward new positions. As a result, views are "allowed to appear much more personal, open to debate and generally contingent" (Gilbert & Mulkay 1984, p46). This contingent repertoire gives access to the various whims, peculiarities, and social interests that also go into the construction of scientific knowledge. More critically, it provides insight into the reasons why scientific findings are so subject to interpretative flexibility. In turn, this allows us to move beyond arguments that rely on the truth, rationality, success, or progressiveness of a given argument as this is precisely what is at stake in the resolution of controversy (see Collins 1981a). It was a result of analysing the literature and interview texts alongside one another in this

way that it was possible to discern how different contexts would produce different mobilisations of language and the use of different concepts.

Following Gilbert and Mulkay (1984; also Gray 2014) I made use of semi-structured interview during this research. While I was constrained in my ideal choice of research methodology with some participants I sought to replicate the way in which I framed questions and their follow through where I was required to illicit response through open-ended survey and email correspondence alone. Interestingly, there was no obvious difference in the quality of each for the purposes of this research. While survey responses and email correspondences were generally shorter, they were also more precise and more explicit. That said, they were not always more concise, one survey participant produced 14 pages in response to my questions and provided a remarkable insight into their work and thinking despite being unable to participate in an interview. There were a number of generic questions that I needed to ask all participants: such as “What is the Anthropocene?” “How do you define the Anthropocene?” and “Do you think that the Anthropocene is a valid concept?” The answer to these deceptively simple questions gave some sense of the boundary work being performed by respondents, their own sense of the field, and served a logistical purpose by creating a unifying thread to all interviews and tethering conversations to my research questions. Beyond this, questions often related to more specific details of that participant’s engagement and were therefore not reducible to a universal schedule. For some, these questions related to the technical specifics of their work or the specifics of the process of stratigraphic formalisation (see Collins 1975), for others the nature of their own engagement had little to do with the technical specifics of the Anthropocene controversy rendering such questions unhelpful. Some of my participants defined their work in terms of a normative prescription of how best to ‘steward’ the earth. In these cases, the notion of proving the Anthropocene as a fact through the medium of formal stratigraphy was important to them and technical discussion alone could not illustrate this aspect of their work. As a result, semi-structured interviews provided a useful compromise between the need for a cohesive overall structure to the research project, the ability to focus on the specifics of an individuals’ work, and the ability of a looser format to create the space for

participants to follow their own trains of thought. Similarly, little anecdotes given during interviews clarified that positions held in opposition to the Anthropocene did not originate from a position of climate scepticism, but rather that all participants shared a concern about the nature and extent of human impacts on the planet. I had not thought to ask such a question directly, but by creating space within interviews my participants rewarded me with additional information. Providing the opportunity to recover these dimensions to their work seemed crucial to me in producing an account of the situatedness of the research practices involved in the Anthropocene (see Avis 2002).

I performed interviews or surveys with every member of the AWG who was willing to engage with this research. Loose groupings of scholars outwith the AWG were generally far smaller, so I was at liberty to interview exhaustively the two to three proponents of a variation of the Anthropocene subject to their availability and willingness. In total I performed 35 interviews with 36 participants. A pair of collaborators performed a further 4 interviews with AWG members on which I performed my own analysis.⁸ As with the literature analysis, these interviews were split between questions about the attempts to formalise the Anthropocene and questions about the response to the supposed politics of the Anthropocene. Interviews generally lasted between one and one and a half hours, although the longest interview I performed lasted closer to three hours. I chose to conduct the majority of my interviews via Skype for wholly practical reasons. While there is some debate as to whether or not virtual interviews produce a different kind of data (see Fontana 2001), this project had no reason to make use of the ethnomethodological tool set (see Garfinkel 1996) because there was no obvious laboratory or fieldwork practice to the Anthropocene controversy as I have detailed it here that would enable such an analysis. Of note, the aim of interviews was to gain greater clarity and insight into topics and epistemic perspectives with which I was not intimately familiar and to learn about the motivations of interlocutors. That is to say, interviews were not about drawing out information from reluctant suspects or questioning the scientific claims behind the Anthropocene, but more about participants helping me to understand their work.

⁸ I detail the nature of that collaboration in Appendix 3.

3.3. Methodological Considerations

Research is as much a situated, political practice as it is an intellectual one. This raises questions regarding the validity of any interpretation of the work of scholars engaged in the Anthropocene controversy. As a result, it was important to recognise that ethical research extends beyond a simple box-ticking exercise to include how I negotiated access with my participants, and how I handled my research data.

3.3.1. Validity

Concepts like truth, validity and credibility help to mediate cultural understandings of good research. In this thesis I had to contend with these concepts on two levels. On the one hand I had to negotiate how the truth, validity and credibility of claims were brought to bear in debates about the meaning and impact of the Anthropocene concept. On the other hand, those same concepts had a massive bearing on the value my own research could bring to those debates. While this presented challenges in itself, I had also to contend with the fact that access was to be gained through the very individuals whose work I had placed under critical scrutiny. In this light, the front end of this thesis is an act of self-limitation. To the extent that these chapters explain how a series of conclusions were reached - by virtue of laying out a philosophy of approach and a technique to the retrieval of data - they also explain why other conclusions were not reached. In this sense the literature review and the methodology delimit my approach by explaining the partiality of the perspective on display. Such an observation is not simply pedantry but rather forms a methodological imperative for work in the sociology of scientific knowledge and is referred to by David Bloor as the 'tenet of reflexivity' (1991).

As Collins has noted (1981b), wranglings over the validity of the relativist programme are old hat, with every study seeking to defend non-positivist research into science anew. Nonetheless there were two imperatives at play in the controversy that justify a stance on this: firstly, a notion of validity grounded in the epistemic authority of certain

disciplines was a central motivating factor for those who engaged with the Anthropocene; and secondly, given how important this issue of 'validity' was to the controversy at hand it would have been a grotesque abdication of the tenet of reflexivity to pretend that my own analysis could provide a complete and singular narrative of that controversy. In my view, disagreements around the appropriate representation of human impacts, which disciplines can tell that story with authority, and the language they might use to do so were key motivators for scholars engaged in the controversy. As a researcher I had some responsibility not to reinforce these points of tension. In effect, questions of representation, authority, and language tied my methodological considerations and the content of the Anthropocene controversy to one another. Therefore, in my analysis I remained conscious of this context and how it could influence the research experience (see Rapley 2007; Miller & Glassner 1997; Collins 1996) and have tried to account for this as much as possible.

Cindi Katz (1994) notes how fieldwork is a process of constructing boundaries. The function of these boundaries is to spotlight particular phenomena for the research process by constituting them as part of a field of study. The difficulty is that the constitution of a field abstracts the very phenomena we seek to investigate, fracturing the vision of reality we set out to convey. In this instance, the most obvious difficulty here relates to the way in which some of the texts that were under investigation, such as STS and constructivist engagements with the Anthropocene, both informed the theoretical orientation of my research, and constituted research objects in their own right. Authors like Donna Haraway (1988; 1991; 1992; 2011) and Bruno Latour (1987; 1988, 1992; 1993; 1996; 1999a; 1999b; & Woolgar 1986) had a 'pre-Anthropocene' life that informed my theoretical orientation to the Anthropocene, but also produced a latter body of work that contributed to the Anthropocene controversy in complicated ways that were not reducible to commentary alone (Haraway 2015; 2016a; 2016b; et al 2016; Latour 2012; 2013; 2014; 2015; 2017). Likewise, Noel Castree produced a substantial body of work that considered the Anthropocene with regards to the discipline of geography (Castree 2014a; 2014b; 2014c; 2014d; 2015a; 2015b; 2015c; 2016a; 2016b; 2017a; 2017b) that helped to inform my sense of the stakes of this controversy.

The very extensivity of this work and its 'active' stakes moved it beyond a simple reflection on the controversy towards what Edward Woodhouse has called a 'reconstructivist' engagement (see Woodhouse et al 2002). It was, in this sense, a very part of the controversy it sought to analyse (see Taylor 1996, p10). Elsewhere interlocutors in the controversy evoked Thomas Kuhn's notion of the paradigm shift (Hamilton 2015; 2016a; 2016b; & Grinevald 2015; Maslin & Lewis 2015; Steffen et al 2016), and Karl Popper's notion of falsifiability (Ruddiman 2016a; 2016b; forthcoming) as part of a rhetorical strategy to defend their work. Complicating things further, two members of the AWG - Jacques Grinevald (1992) and Naomi Oreskes (2003) - were themselves STS scholars, while another member of the AWG felt that they could not refuse the invitation to participate in my research because they had themselves written a doctoral thesis exploring scientists at work (1x email). A few of my interview participants in the social sciences - a neomarxist critic, a geopolitical theorist, and an environmental economist - seemed acutely aware of George Lakoff's work on 'framing' and the power of metaphors (see Lakoff 1993; 2010) and used this thinking to inform and rationalise their own adoption and engagement with the Anthropocene controversy (3x interviews). Rather than being somehow oblivious to the social dimensions of their work that I might seek to analyse, they were able to analyse and justify their own use of the Anthropocene in sophisticated ways. The result challenged my capacity as researcher to maintain a clear distinction between theory and object.

Despite sharing an acceptance and concern about the anthropogenic changes the Anthropocene was being used to signal, I must also be honest about approaching the concept from a position of initial scepticism and concern about the political imaginary it conjured. This view was informed by existing scholarship about the role of technoscientific narratives on political questions (see Wainwright & Mann 2013; Swyngedouw 2010). In an attempt to counter these preconceptions I approached the project from the ground up considering how individuals, disciplines and institutions tried to define and delimit the Anthropocene and to what end, rather than accepting one particular disciplinary lensing of the concept or simply accepting the Anthropocene as a

question of when and how to define a boundary in geological time. In this sense I attempted to remain an impartial outsider to the controversy (see Bloor 1991), while recognising that as much as I could constantly try to expand the distance from which I observed the Anthropocene, I could not really escape its orbit. Harry Collins (1996) has noted that researchers might find themselves attached to the thing they study; coming to like certain positions and feeling them to be worthy of support. Steven Yearley has objected to such a notion by suggesting that it is “far from clear how the analyst can both be a methodological relativist and - at the same time - take a view on the merits of the case” (2005, p106). Unfortunately, this issue does not seem an easy one to rectify. As researchers we either pretend that we are capable of completely absolving ourselves of bias - which is dishonest - or we can try to acknowledge how that bias might affect our judgement. As much as I might attempt to step outside of myself in the performance of the research I ultimately had to recognise the artificiality of the distinction drawn “between research and politics, the operations of research and the research itself, the field and the ‘not field’, the researcher and the participant” (Katz 1994, 67). Ultimately, I serve the material best by leaving my subjectivities on the page, signalled by the use of the first person, and recoverable to the reader (Law 2000; Peräkylä 1997; Davis 1992).

3.3.2. Ethics

Your name and any other personal information, such as organisational affiliation, can be made anonymous at your discretion. The information collected from interviews will be securely stored in line with the Data Protection Act (1998) and destroyed after my research has been completed.

(Consent form used in this research)

This research incurred a number of obligations on the part of myself as researcher, including the need to gain valid and informed consent from all participants. Accordingly, all participants were over the age of 18 and were informed of my obligations to them under the UK Data Protection Act (1998). Because participants gave explicit and active

consent to participate in this research⁹ and because I retained no personal data after anonymisation, this research conforms to the General Data Protection Regulations (GDPR) that came into effect on the 25th May 2018. Further, this research drew on the School of Geosciences' own ethics framework and was fully in compliance with that of the Economic and Social Research Council who funded it. Critically, the objective of this thesis was not to question the science at play within the Anthropocene controversy. Rather, it was to engage with the processes by which scientific claims were being mobilised in academic and public settings during a controversy that had generated such wide-ranging interest. As discussed in the previous chapter, the Anthropocene concept sits at the complicated interstices between disciplines and between science and the public, and its precise form is subject to open and wholly justifiable interpretation by the various interlocutors engaged in the controversy. Recognising this, I made it clear during enrolment and interview that it was not my intention to make judgements about the value of any of the work my participants produced, nor was it to evaluate the kinds of scientists or researchers they are. To paraphrase Mol, my aim was to get to know their standards, rather than to apply my own (2002a). In keeping with this aim it was important to respect and maintain the anonymity and confidentiality of all participants. Within the context of the thesis the value of individual voices was to help demonstrate the broader dynamics of the controversy. Rather than draw undue scrutiny to individual decisions or privately held motivations to engage with the controversy in particular ways, my intention was simply to use individual perspectives (where given) to illustrate the range and breadth of motivations, interpretations, and opinions that helped to shape the making of the Anthropocene as an epistemic thing. While I have been mindful to minimise the risk of reputational harm for participants, it may have been the case that participants did not share this confidence. As discussed below - under 'Negotiating Access' - I recognise that this assumption may have had an impact on the willingness of some potential participants to take part in this research and that it will have influenced the conditions of access for some of those who did.

⁹ I include a blank information and consent form for participants in Appendix 4.

3.3.3. Negotiating Access

Sorry to disappoint, but I have grown tired of discussing the anthropocene.¹⁰ You can find my views on the matter in a short invited article I wrote for *Science* last spring. Basically I think it is a waste of time to try to define one unique starting point for a process that has been building gradually for thousands of years.

(rejection email)

As regards direct observation of our working discussions, it is clear from the range of responses that this might in some cases have the effect of altering people's willingness to participate and speak freely - and so altering the very phenomenon that you wish to study. Hence, such observation might be best done at meetings which are designed to be open discussion meetings, rather than at our (rare and hence very valuable to us) working meetings, such as the one at Cambridge on 24-25th November that we have previously mentioned.

(AWG gatekeeper email)

More than 50% of the interviews that I requested were not granted. Although there was not a particular pattern that I could discern, anecdotally I would suggest that those who felt their own engagements to be deconstructions of the Anthropocene could see less value in time spent supporting another in deconstructing the Anthropocene controversy. Beyond that, I felt that those who had the greatest institutional support in making their claims could see no benefit in discussing their views beyond certain formal spaces. At stake for both groups was an ability to control their output, lest it be open to (my) misinterpretation. This was perhaps unsurprising given that the Anthropocene remains a site of active controversy. Beyond this, the most obvious distinction to be drawn was between those for and those against some conception of the Anthropocene. Those in

¹⁰ The use of a lowercase 'a' in the Anthropocene by the respondent was deliberate here, not a typographical error.

favour of the Anthropocene could perhaps sense that there was something to lose in conversation, while those against - generally lacking the institutional leverage of a body like the AWG or the IGBP - were possibly just glad for the opportunity to present their position. In this sense, it could be that the institutions representing consensus positions on the Anthropocene were more wary of an outsider asking sensitive questions (see Valentine 2001). Requests to observe meetings of the AWG were also rejected. Nonetheless, and despite frustration at being turned down, I did still retain some control over these instances of rejection. I was still able to interpret those rejections, and - as above - I was still able cite them and speculate about why it is that I was turned down. Taken alongside other information that was readily presented to me about the more contested dimension of the Anthropocene concept and the value of the social sciences these instances of rejection became a useful insight to my object of study.

Interaction with the AWG became dependent on the involvement of a gatekeeper with whom I tried to maintain a good rapport (Valentine 2001; Avis 2002). I made first contact with this gatekeeper when I requested to observe the AWG's second meeting in Cambridge on the 24th and 25th of November 2015. The response was negative, but I took a proactive role in administering his request that the four researchers who had made similar requests¹¹ try to work together. The grounds for this assumption that we might collaborate were fairly limited; as email correspondence with the gatekeeper and chair of the AWG made clear, we had been lumped together based on a shared status as social scientists who might alter the willingness of members to participate fully in the meeting by speaking freely and therefore risked "altering the very phenomenon that [we] wish[ed] to study" (AWG gatekeeper email). As I discuss in Chapter 9 of the thesis, the AWG and its members were proactive in promoting the Anthropocene concept in journalistic and popular literature during the same timeframe. This implied to me that the willingness to respond to questions had a lot to do with who is asking as well as assumptions about what that individual might be able to do in helping or hindering the promotion of any given position on the Anthropocene.

¹¹ Initially Prof. Noel Castree (Wollongong University), Dr. George Holmes (University of Leeds), and PhD student Johannes Lundershausen (University of Tuebingen).

I mention this because as much as my relationship with the gatekeeper was genuine, in that I really did attempt to fulfil my side of the bargain with regards to access, this relationship was equally about the performance of a willingness to do things the way they had suggested. I emailed the gatekeeper updates on our collaboration to ensure that we developed a good relationship, and I wrote to congratulate the gatekeeper (and by proxy the AWG as a whole) on publications. However, I would be lying if I did not acknowledge the way in which this primarily served to help me with my own research. By maintaining this good relationship I sought to maintain a primacy of access to the AWG such that - if they did decide to further police our interactions - I might still be granted some limited access. Further, maintaining this kind of a close relationship was a way of overcoming their initial scepticism towards me as a social scientist and an outsider (see McDowell 1998). Lengthy email dialogues with various research participants about my positionality and the role of my research meant that they were more forthcoming and trusting during interview. As well as developing a rapport, and maintaining access, there were other advantages. After emailing to congratulate the AWG on a landmark publication in *Science* in January of 2016 (Waters et al 2016), my gatekeeper responded by sending me a workshop report on the November meeting of the AWG in Cambridge (Edgeworth et al 2016) to which I had been denied attendance. It is unlikely that I would have located this publication otherwise, and neither would I have known to look for it or request it. As a consequence of the development and maintenance of a good relationship with my gatekeeper, I later received an insight (however partial) to something I had initially been denied.

It is hard not to be somewhat cynical about this kind of performance, but it was also necessary. As a result, this kind of engagement with my participants also demonstrates the way in which access - and the negotiation of access - was an on-going process that needed to be continuously tended throughout the research. As illustrated in the email extract below, gatekeepers had the authority to more or less revoke any access I had to the AWG's membership.

Most members expressed agreement to be contacted by E-mail, and potentially by telephone/skype. Initial contact may be in the form of a questionnaire that could be circulated to the members via the Secretary, from which the need for future direct contact can then be determined.

(AWG gatekeeper email)

Other members of the AWG reinforced the sense that the group-as-a-whole was highly anxious about allowing such close scrutiny of their efforts (1x interview), while the above email also intuited larger power structures at play, implying that the response the gatekeeper had sent us was constructed in consultation with the AWG's parent body, the Subcommittee on Quaternary Stratigraphy. As the above example demonstrates, even the mundane acts of negotiating access to research participants gave a sense of the institutional structures at play in determining the stratigraphic reality of the Anthropocene and allowed me to triangulate my analysis more effectively.

3.3.4. Handling Sensitive Data

Beyond simply fulfilling the ethical criteria of my research affiliation and funding body, I felt a sense of ethical duty towards my participants and the communities they represented. The risk for me here, intentionally or otherwise, was to draw the complex dimensions of the Anthropocene controversy into a broader movement towards the commodification of scandal in which we obsess over the slightest faults of individuals or their thinking (see Lee, 1999). In this sense, the Anthropocene needs to be considered alongside questions of 'Science 2.0' as well as broader questions about the transparency and openness of scientific practice (see Demeritt 1996, 2001). To be clear, I do not believe there was anything scandalous about the Anthropocene controversy or the engagement of those involved. It cannot be stressed clearly enough that I do not seek in this thesis to question the reality of anthropogenic change - upon which the scientific consensus is resolutely clear - or the more specific scientific claims pressed by various interlocutors. Instead, the challenge remains one of what to 'do' with that knowledge, how to pronounce upon it, and to what ends. Nestled within these

concerns lies an outstanding challenge regarding whether the Anthropocene can serve as both an observation and an intervention, where the boundaries between those two things lie, and the various different ways in which interlocutors and different disciplines might engage with that challenge. Thus, the more pressing concern is not whether or not specific claims are real but how they are presented, on what authority, and to which audiences. Indeed, a very part of the Anthropocene controversy - as I have understood it - relates precisely to the challenge of a concept whose role and precise disciplinary configuration has been adapted as the concept has been made to move and been given new purposes. Given the nature of these debates, there are, understandably, many ways in which confusion and friction can arise. As the history of the Climatic Research Unit email controversy - or 'Climategate' as it came to be known - illustrates, it does not take much for scepticism to gain significant traction (see Blowfield 2010; Hulme 2009). So while this thesis does not attempt to offer any kind of settlement on the rightness or wrongness of the Anthropocene controversy, it does illustrate some issues and raise some questions about that concept and the motivations of scholars to engage with it. Thus, my research is an intervention via the Anthropocene concept in a series of much larger conversations. In this broader, often politicised context I worry about how much assumed 'bad science' society can handle. And, whether illustrating the unavoidable politics at play in the creation and promulgation of a concept like the Anthropocene risks as much harm as good. On the line in the Anthropocene controversy was not only scientific accountability, but also the narratives through which actors might seek to communicate work produced by the institutions of science.

These considerations have an impact on both the analysis and the writing of my research. I needed to remain attentive to the fact that disagreements over the Anthropocene emerged not only out of differences of perspective, but also individuals' perceptions of the tenor of the controversy. As discussed above, this meant that taking the time to clarify my position of relative neutrality was crucial. Perhaps more importantly, it meant preventing myself from overstating anecdotal evidence (see Lee 1999, p39). In an early interview I encountered a deeply offensive conception of the role of the social sciences from a global environmental change researcher in the

'Anthropocene'-named research group that I studied (1x interview). In this view - which was replicated elsewhere in the interviews - social scientists were treated as navel-gazers more interested in asinine and circular debates than in their 'proper role' translating the work of 'real' scientists and making it publically accessible. Social science was, in effect, an obstacle to the development of human knowledge. I had expected to encounter this view of the social sciences at some point in the research. However, rather than pounce on this moment too excitedly my task was to situate this opinion within broader tensions. This particular opinion was likely more to do with scepticism about my desire to interview. A fearful response, perhaps unintentionally overstated as a consequence of the interview format, more so than a legitimate belief. It is important to register that beyond a box-ticking exercise, ethics is about moral defensibility (see Gray 2014). The above example demonstrates this in practice. There is a tension between the "need to know and the right to remain unknown" (Barnes in Lee 1999, 42) in any work that attempts to situate individuals within broader institutional moments. The desire not to exacerbate tensions between the natural and social sciences as they pertain to the Anthropocene justified the need to treat individual participants and their contributions to this research with appropriate care. In this sense, there was an extensive politics to disclosure located somewhere between institutional context, researcher and participant, and the desire to produce constructive findings that outlive the act of research itself (see Law 2004).

3.4. Conclusion

This methodology has detailed the processes by which I have handled my research object in the production of this research, including the collection and analysis of a large tranche of written materials, and the performance of a number of interviews, surveys, and correspondences with the authors of those materials. I have detailed these processes, while at the same time raising a number of considerations about methodology and ethics. First and foremost amongst my aims with this chapter was an ambition to foreground a conversation about the partiality of the perspective deployed here (and indeed all research), the ethical obligations incurred upon me by this work, and the role of this research within a series of broader conversations. Exploration of the Anthropocene controversy inserts me into a shared conversation about values, and in navigating this terrain I have drawn upon my own experiences, education, and personality. While I have sought to produce a robust and defensible thesis, the claims that I make are necessarily co-constituted and partial (see Haraway 1988). As a result, the vision of the Anthropocene controversy that appears in this thesis cannot be separated from the research that I performed, and cannot be said to exist separate of my method (see Law 2004).

Chapter 4: The Onset of the Anthropocene Controversy

4.1. Introduction

In this first empirical chapter I wish to establish the Anthropocene as an ‘epistemic thing’ in historian of science Hans-Jörg Rheinberger’s sense (1997). Rheinberger derives his concept of the ‘epistemic thing’ from Foucauldian archaeology and ‘discourse objects’, noting the need for scholars to pay as much attention to the things that embody concepts as to ideas themselves (p8). Rheinberger uses the ‘epistemic thing’ to talk about laboratory systems and the stabilisation of somewhat more discrete material objects like RNA. However, in developing his arguments, sociologist Karen Knorr Cetina notes the value of ‘epistemic things’ as a tool to chip away at the “wholeness, solidity, and thing-like character” that objects of knowledge have in our everyday conception” (2001, p181). Thus, for the purpose of this thesis I needed a term to describe a scientific object that is as-yet-undefined and could capture the vagueness of a scientific knowledge object in the making, both for the interlocutors that wielded the term and those who sought to respond to it. Following Rheinberger’s arguments I conceive of the Anthropocene controversy itself - although it played out mostly in the literature and not in the lab - as an experimental system for producing meaning(s) for the novel concept ‘Anthropocene’. Despite the shift I enact in moving Rheinberger’s thinking from a laboratory setting to the more discursive stage of journals and other literature, there are questions to ask of the Anthropocene that share much in common with his original analysis of protein synthesis. For example, the question of whether research begins with a theoretical framework or whether it proceeds from research materials or the experimental system itself (1997, p26) is as pertinent here as it was for Rheinberger. Likewise, the Anthropocene represents a situation in which an epistemic thing was subject to arguments over its precise definition and yet never conclusively defined. In effect, the willingness of interlocutors to invest in what might be achieved through the Anthropocene meant that the present status of the concept was always highly dependant on the future that they imagined for it (Knorr Cetina 2001, p175).

In all that follows the Anthropocene was generative of a controversy, but a clear sense of what the Anthropocene itself was - subject to on-going definition and on-going boundary negotiation - remained largely absent from the questions it was used to generate (Rheinberger 1997, p36). Instead, those who wished to deploy the concept to different aims held the precise meaning of the Anthropocene in flux. In the period that this thesis covers - Feb 2000 until the end of 2016 - the epistemic thing called 'Anthropocene' retained a surprising level of "metastability" (Rheinberger 1997, p226). That is to say, the Anthropocene came to occupy a clear and relatively stable space in academic discourse, and received sustained intellectual interest from a wide range of interlocutors with sometimes complementary and sometimes contradictory interests and stakes (see also Knorr Cetina 2001, p182). While the fate of the Anthropocene is not yet decided, there are reasons to suggest that it may later become marginalised because nobody any longer expects it to generate what Rheinberger calls the "unprecedented event" of new knowledge (1997, p80). In this possible future, scholars no longer view the Anthropocene as something provocative enough to justify its deployment. As a heuristic, it no longer encourages scholars to think in new ways about the human relationship with the world. Alternatively, the Anthropocene might "become silenced," recede into the background, and live out the rest of its days as an unquestioned piece of technical vocabulary (p226). In either case, once the Anthropocene has received whatever 'historical eventuation' surely awaits, it will become increasingly difficult to avoid "the illusion that it is the inevitable product of a logical inquiry or of a teleology of the experimental process" (p74). As Rheinberger notes, epistemic things like the Anthropocene need not shape the discursive framework of the disciplines they interact with from the beginning. However, once established the response of scholars to their presence has the capacity to change the intellectual practice of whole research agendas to such an extent that only a short time later a newcomer would have difficulty understanding what the generation before had been talking about (p186). In each instance - and I suspect that the Anthropocene might have different fates among different communities - the dynamics of the controversy as it played out between 2000 and 2016 will help to shape that outcome.

This chapter tells the first part of this story by setting the scene for this particular scientific controversy. The first section recounts the emergence of the Anthropocene as an ad-lib at a scientific meeting, and considers the consolidation of that ad-lib into a pair of short publications. In so doing, I set out the parameters of the controversy that follows. These include a specific technical question about the onset of a new geological epoch, and a broader question about the role the knowledge of that new epoch was intended to play within a series of broader discourses. The second section of this chapter builds on the first by considering the further consolidation of the Anthropocene by its originator - Paul Crutzen - and his colleagues working with their new concept at an institutional level. Their actions served to strengthen the relationship between this ad-lib and the discipline to which it nominally signalled. By drawing on a series of historical precursors, Crutzen and his colleagues presented the Anthropocene not as a transgression of disciplinary expertise, but as a deliberate, logical, and obvious progression of existing thought within that discipline. This section also demonstrates how Crutzen and his colleagues sought to make explicit the normative role that their epistemic thing was to play in broader political discourse. The final section of this chapter considers the role of individual expertise and situational contingency in making Crutzen's Anthropocene claims move. In particular, I explore the influence that the individual status of Crutzen exerted on the controversy that followed, and the role that his Nobel Prize-winning status played in establishing and maintaining the Anthropocene controversy.

4.2. Ad-libbing the Anthropocene

In February 2000 in Cuernavaca, Mexico, the International Geosphere-Biosphere Project's (IGBP) Scientific Committee had their annual meeting. During one session, scientists from the palaeo-environment work group of the Past Global Changes (PAGES) project met to discuss their research on climate reconstructions. During this meeting, the group made regular reference to the Holocene, the current interval of geological time. This interval denotes the last 11,700 years of the earth's history, and was formally ratified as an epoch of geological time by the International Commission on

Stratigraphy (ICS) in 2008 using an ice core from the North Greenland Ice Core Project after having been long adopted in the geological community as a informal division (Walker et al 2008; 2009). The Holocene itself represents the most recent interglaciation of the Quaternary Period, which covers the last 2.6 million years of the earth's history. During the Quaternary Period the earth has switched between intervals of glaciation and deglaciation. Because perennial ice has remained on the earth's surface throughout its duration, Quaternary scholars consider the entire of the Quaternary Period to be an ice age (see Denton et al 2010). The dominant 'forcing' throughout this interval of earth history is understood to be the result of Croll-Milankovitch cycles, the combined variation in the earth's orbit around the sun in terms of eccentricity, axial tilt and precession (Lowe et al 1997). These Croll-Milankovitch cycles influence climate change in 100ka, 43ka, 24ka, and 19ka cycles, with the longest interval driving the process and the shorter intervals modulating and amplifying the effects of the longest cycle in diverse ways (p13). Due to the predictability of these cycles it has been argued that absent the specific discussion about human impacts that the Anthropocene has triggered - although with some account of anthropogenic climate change - the earth will return to a glaciated state within the next 50,000 years (see Berger & Loutre 2002).

Certain interlocutors in the Anthropocene controversy contest the validity, usefulness, meaning, and contingency of the Holocene as a practical division of geological time and what its own status means for the Anthropocene. For example, it is argued that it is the very presence of anthropogenic signatures that defines the Holocene, without which there "would be no justification for the Holocene being anything other than an interglacial, in common with all others in the Pleistocene" (see Gibbard and Walker 2014, p32). This point, made by two of the authors most closely associated with the formal ratification of the Holocene later served as a justification for stratigraphers who argue against the utility of the Anthropocene to say that the idea of human impacts had already been taken account of in the International Chronostratigraphic Chart (1x interview), and as an opening by stratigraphers in favour of formalising the Anthropocene to point to the value of practical convenience and "the need to find the most effective boundary" (and not just 'science' and 'facts') in the delineation of the

International Chronostratigraphic Chart (1x interview). While the exact status, role, and function of the Holocene is - evidently - still subject to some debate, the Holocene was at this point in time a well-established feature of the geological time scale regularly used by geoscientists in discussion of the geologically recent past.

During this meeting of PAGES, Paul Crutzen - acting in capacity as the vice-chair of the IGBP - grew agitated by the many references being made to the Holocene, and his frustration culminated in an outburst that resulted in an extended period of silence. As the then executive chair of the IGBP - Will Steffen - recalled:

Paul... was becoming visibly agitated at this usage, and after the term Holocene was mentioned yet again, he interrupted them: "Stop using the word Holocene. We're not in the Holocene any more. We're in the... the... the... (searching for the right word)... the Anthropocene!

(Steffen 2013, p486)

While Crutzen does not appear to have said much more at that time, there was muttering in the wings once the meeting broke for coffee and later into dinner (1x interview). Those in attendance were asking if Crutzen was onto something and whether this term 'Anthropocene' could serve as an "organising concept" for the ten years of global change research that the IGBP had been working on (ibid). Sensing both the value of a single term that could "[encompass] something really fundamentally important and big," and the interest sparked by this single utterance (ibid) the directors of the IGBP saw the opportunity to consolidate this neologism in writing. With this in mind, they approached Crutzen to write an article for the IGBP newsletter due for publication a few months later in April (ibid). That short piece, entitled 'The "Anthropocene"' (Crutzen & Stoermer 2000) was co-authored by biologist Eugene Stoermer, a diatom specialist from the University of Michigan. While Stoermer had been using the Anthropocene informally in undergraduate teaching since the 1980s he was apparently not interested in pursuing the Anthropocene further (1x interview). Uninterested in the "wider context" that Crutzen intended (ibid) Stoermer appears to

have accepted co-authorship in good grace, but his contribution was minimal. Given Stoermer's death in 2012 and the fact that there are no other written records of Stoermer using the term before or after 2000 it is hard to know the extent of his own personal contribution to this first material artefact in the Anthropocene controversy.

'The "Anthropocene"' was a short article, around 1000 words long and comprising of little more than a single side of A4. Nonetheless, this short article did a number of things to set up the Anthropocene controversy that followed. Firstly, Crutzen restated his belief that the Holocene had ended. He achieved this by stating that the Holocene "seems" to have been proposed in 1833 before being adopted more widely in 1885 at the International Geological Congress (Crutzen & Stoermer 2000, p16). Given that Crutzen referenced his information on the Holocene and its formalisation to the Encyclopaedia Britannica (ibid), it appears that Crutzen's structured his early thinking on the Anthropocene in this short article through his knowledge of contemporary global change more so than a deep awareness of the International Chronostratigraphic Chart or its institutional machinery (for more information on these see Hedberg 1974; Salvador 1994; Ogg 2004; ICS 2013). Instead, Crutzen appeared to interpret the formal strictures of stratigraphic practice and its naming conventions in a loose way. In particular, Crutzen disregarded the convention of "erecting formal, named units [at an] advanced stage of analysis", and the role of specialist stratigraphers in leading such efforts (Miall 2016, p312). Instead, in this first article Crutzen suggested that the name 'anthropocene' should "emphasise the central role of mankind in geology and ecology" (p17). As a number of stratigraphic interlocutors have since argued, divisions of the International Chronostratigraphic Chart have historically been named for descriptive, rather than causative reasons. For example, as Kieran Suckling has noted, the Holocene is so-called to reflect contemporary biota as contrasted to past biota (see Suckling 2014¹²; also Finney & Edwards 2016, p6¹³). Thus the decision to emphasise

¹² In greater detail, the current divisions of the Cenozoic Era (the past 66 million years) were named for the relative prevalence of modern fauna, as Paleocene (oldest new fauna), Eocene (dawning of new fauna), Oligocene (few recent fauna, compared to today), Miocene (less recent fauna, appearing), Pliocene (more recent fauna, appearing), Pleistocene (most recent fauna, have appeared), and Holocene (entirely recent fauna, are present) (Suckling 2014).

the role of humans in naming of the Anthropocene implied a normative dimension to Crutzen's choice of name to which I will return below. In similar contrast to the accepted norms of the International Chronostratigraphic Chart, Crutzen gave an approximate start date in the late 1700s to coincide with the "beginning of a growth in atmospheric concentrations" of carbon dioxide and methane during the Industrial Revolution, as recorded in glacial ice cores. Despite opening up the possibility of other onsets, Crutzen expressed that "[assigning] a more specific date... seems somewhat arbitrary" (ibid). That is, for Crutzen, it was the fact of change that was more important than the process of locating a globally isochronous onset to that change (c.f. Salvador 1994). Nonetheless, Crutzen actively positioned the Anthropocene as a geological concept, and drew on a number of historical works to do so. These include George Perkins Marsh's *The Earth as Modified by Human Action* (1864), Antonio Stoppani's (1873) argument for mankind as a "telluric force" ushering in a new 'Anthropozoic' era of geological time, and Vladimir Vernadsky (1926) and Teilhard de Chardin's (1924) idea that greater consciousness and greater influence over the planet would lead to a 'noösphere', "[a] world of thought" (Crutzen & Stoermer 2000, p17). The effect of these references was to situate the Anthropocene as a historically consistent successor concept to previous conceptualisations of the human impact on the planet that spoke to similarly geological stakes.

Secondly, Crutzen positioned his concept of the Anthropocene as a political intervention. In support of the argument that we take seriously the impacts of humans upon the planet, Crutzen listed a range of human impacts, from population growth, the introduction of synthetic pollutants and chemicals, to land and fishery resource depletion. More pointedly, Crutzen established a narrative of 'dominance' and of the 'overriding' of nature by describing the 30% increase in atmospheric carbon dioxide since the Industrial Revolution, the 100% increase in atmospheric methane in the same time frame, and the fact that anthropogenic sulphur dioxide from fossil fuel combustion

¹³ Likewise, Finney and Edwards note that "the bases of the Ordovician [485.4 - 443.8 mya], Devonian [419.2 - 358.9 mya], Carboniferous [358.9 - 298.9 mya], and Permian systems [298.9 - 251.9 mya] were placed at the lowest occurrences of single graptolite or conodont species," and were chosen for the possibility of worldwide correlation, and not named on the basis of historically significant events (p8).

emissions now outpaced natural emissions by a factor of two. Crutzen suggested that these changes would have ramifications for at least the next 50,000 years of earth history and he explicitly framed his observations as existential risks that required response. That is to say, Crutzen seemingly wished ‘us’ to respond to his provocation by recognising the role of humans in changing the earth, and hoped that we might do something about that. Crutzen invited further political intervention by pointing to his own work on chlorofluorocarbon gases (CFCs) - for which he received a Nobel Prize in 1995 - to note that anthropogenic CFCs “would have destroyed much of the ozone layer if no international regulatory measures to end their production had been taken” (Crutzen & Stoermer 2000, p17). In creating a space for a political response to this putative new epoch Crutzen pointed to the “exciting... and daunting task [that] lies ahead” in the development of a “real functioning... noösphere” with a central role for engineering and technology in the development of sustainable environmental management (ibid). In this way Crutzen envisioned a particular role for science and engineering and a collective vision of humanity to face the shared burden of anthropogenic global change.

Given the status of ‘The “Anthropocene”’ - as a non peer review piece within a newsletter publication intended for the IGBP’s own specific community of researchers - this short article had limited impact beyond this particular research community. Nonetheless, Crutzen continued to make use of and popularise the term amongst broader audiences with a pair of conference presentations in 2000 and 2001 (as 2001; 2002b respectively). At this time Crutzen also co-authored a short commentary with Will Steffen in response to an argument about early anthropogenic increases in methane published by palaeoclimatologists William Ruddiman and Jonathan Thomson in 2001¹⁴ (Crutzen & Steffen 2003). Due to Crutzen’s on-going efforts the Anthropocene became influential enough to warrant a further elaboration in the journal *Nature* in 2002, which Crutzen authored without Stoermer. This second paper - ‘Geology of Mankind’ (Crutzen 2002a) - represented the point at which the Anthropocene started to gain critical traction

¹⁴ This paper (Ruddiman & Thomson 2001) actually made no reference to the ‘Anthropocene’ itself, but was nonetheless drawn into the controversy because it spoke to a similar question; the onset of significant human impacts on the climate. I will discuss the involvement of Ruddiman in the broader Anthropocene controversy in more detail in Chapter 7.

beyond the IGBP community, with a more than twenty-fold increase in citations over the first article. This article was similar in scope to the previous effort, reaffirming many of the narratives that the earlier paper had established. Crutzen was again vague in his application of stratigraphic language, presenting the Anthropocene as both a “geological epoch” and an “era”, terms that have specific and distinct meanings (p23). George Perkins Marsh, Antonio Stoppani, Vladimir Vernadsky, and Teilhard de Chardin were again given specific reference to position the Anthropocene as an epistemic thing for geological inquiry. And, as before, Crutzen listed a range of contemporary anthropogenic impacts on the planet to establish a narrative of humans “overriding” natural processes (ibid). Rather than a list of references the article drew on claims that were so well established and accepted within the community of scholars Crutzen targeted that they did not require specific citations (see Latour & Woolgar 1986, p76). For example, Crutzen did not offer citations for the tenfold increase in the human population over the past three centuries, the 30% increase in global atmospheric carbon dioxide over that same period, the transformation of 30-50% of the land surface by agriculture and urbanisation, and the 16-fold increase in energy use during the twentieth century that support his central claim to overriding human influence. In this sense Crutzen did not mobilise a new evidential case, but instead appeared to synthesise established facts to make a new argument with greater appeal than each of its constituent parts. He drew on existing knowledge and cultural resonances around anthropogenic global change, and repackaged these as ‘the Anthropocene’ to produce something new (see Lievrouw 1990, p6). As before, Crutzen tethered this narrative to future change with the ominous projection of “more to follow” (2002a, p18). And, he again highlighted the importance of the Anthropocene in terms of triggering a technological and engineering response. On this, Crutzen goes further than before by suggesting a role for planetary modification - or ‘geoengineering’ - in response to global change.

[sustainable management of the Anthropocene] will require appropriate human behaviour at all scales, and may involve internationally accepted, large-scale geoengineering projects, for instance to ‘optimise’ climate.

In doing so Crutzen not only maintained the tethering of his particular observation of change to the possibility of a political response but also specified the particular direction that response might take.¹⁵ Thus, in Crutzen's early written work on the Anthropocene there was a consistent pattern. He presented a series of well-established observations about the impacts of humanity on the planet, drew these together to present a new geological 'epoch' to be called Anthropocene. And, perhaps critically, suggested that awareness of the fact of the Anthropocene should provoke a (necessarily) political response.

4.3. Knowledge on Whose Authority? And to What End?

It is worth briefly outlining and clarifying the dynamics of the controversy that Crutzen initiated with these short articles. Firstly, Crutzen made an observation about change that he grounded in his experience at the IGBP. In his written output this change was largely presented in qualitative terms - like relative increases in the emissions of greenhouse gases - but Crutzen bound these qualitative insights together using a metaphor of 'dominance' (2002a, p23). And, Crutzen's arguments appeared to be a synthesis of known particulars rather than the mobilisation of new facts. In lieu of a reference list Crutzen instead pointed to some 'Further Reading'. Key amongst this further reading was an article by earth system scientist Hans Joachim Schellnhuber, written three years previously and similarly published in *Nature* (1999). Crutzen did not make reference to the 'earth system' or to 'earth system science' in his writing.

¹⁵ Serious consideration of geoengineering in response to contemporary global change is an issue that Crutzen has explored elsewhere without specific reference to the Anthropocene (Crutzen 2006) although the two are now largely entangled due to an overlap in institutions and personnel. For example Steffen, Crutzen & McNeill (2007) and Steffen et al (2011a) both feature Crutzen as a co-author and continued to pursue Crutzen's suggestion that geoengineering represented a plausible response to climate change and made that case within the framing of the Anthropocene. As above, perhaps more important than geoengineering itself and the debates that surround the ethics of such an intervention (Anshelm & Hansson 2016; Horton 2015; Huttunen et al 2015; Reynolds 2015; Robock 2008; Preston 2012) was the suggestion of a pre-decided trajectory in response to the problem that Crutzen outlined in the Anthropocene. That is, Crutzen drew a straight line between his observation and the appropriate outcome, which was - in his view - to revolve around geoengineering.

Nonetheless, Crutzen's inclusion of Schellnhuber's article in this list demonstrates the centrality of earth system science (ESS) - an emergent disciplinary synthesis based on cybernetics and systems theory - to his vision of the Anthropocene. Given that Schellnhuber's article argued that ESS represents "a second Copernican revolution" in the form of a new paradigm through which the planet was to be understood, this seems to be a critical inclusion given very little fanfare in Crutzen's writing.

Secondly, Crutzen labelled those changes in accordance with geological or stratigraphic nomenclature by calling this change 'epochal'. Rather than simply using geological time as a metaphor or heuristic to illustrate the magnitude of change, Crutzen's call for a new epoch was both completely literal and served as an attempt to produce a technical definition for use amongst all disciplines that make use of the geological time scale. Crutzen stated that the Holocene had ended and should be supplemented by this new epoch (ibid). In creating an historical lineage to the Anthropocene, Crutzen implied that stratigraphy was the appropriate framework through which to talk about his new concept and mobilised the language of this discipline to support his own claims. In transposing an observation of change drawn from an (unstated) ESS perspective into stratigraphic terminology Crutzen set up a challenge between two different disciplinary practices - ESS and stratigraphy - that continues to this day to exert an influence on the Anthropocene controversy, and which I will explore over the following chapters. Finally, while Crutzen's invocation of the Anthropocene was an observation - albeit one subject to competing ways of knowing and describing change - it also made normative prescriptions about that observation. That is, Crutzen implied that the Anthropocene ought to be used to 'world' (see Mol 1999, p75) a particular kind of response that was - for Crutzen - self-evidently contained within the fact of change that he presented. This worlding was evident in the suggestion that the observation of change should be labelled in such a way as to emphasise change to an (unspecified) audience, to the prescription of a specific suite of responses in the form of geoengineering and sustainable management. Thus - at the same time as placing the Anthropocene in an undetermined disciplinary space - Crutzen's Anthropocene transgressed the important -

albeit contested - cultural boundary between science as an observational practice and science as a political practice (see Taylor 1996).

Despite limited early uptake and limited impact, a number of researchers did start to make use of the Anthropocene as a means to contextualise a high carbon world of anthropogenic 'earth system' change. One early - and high-profile - adopter of the concept was Michel Meybeck, the director of research at the French National Centre for Scientific Research (CNRS). Meybeck made reference to the Anthropocene in a number of papers between 2001 and 2005 that analysed the influence of human impacts on continental aquatic systems (Meybeck 2001; 2002; 2003; 2005; Meybeck & Vörösmarty 2005). A number of other scholars followed Meybeck's lead in adopting the Anthropocene to contextualise contemporary global change research (for example Anderson et al 2005; Claussen et al 2005; Crossland et al 2005). In these papers Meybeck deployed the Anthropocene to situate his argument that "anthropogenic control and/or pressures on river systems has accelerated in the past 50 years and is now balancing the earth system controls," leading to a "new era that follows the Holocene" (2003, p1941). Like Crutzen, Meybeck was vague in his use of stratigraphic language and referred to the Anthropocene in terms of an 'era' despite the epochal suffix '-cene' (p1935). In spite of his evocation of the Anthropocene in the titles and bodies of his papers, Meybeck did not focus on a lengthy discussion of the concept. Even as scholars like Meybeck began to adopt the term, Crutzen continued to work with Will Steffen to consolidate an ESS reading of the Anthropocene (Steffen et al 2004; also Steffen, Crutzen & McNeill 2007). This work built upon Crutzen's earliest invocations and helped to further facilitate the movement of Crutzen's expertise from one domain, ESS, to two others. The first being the specific disciplinary formation of stratigraphy, from which his claims drew a part of their authority and their cachet, and the second being the world of politics, in which his new epistemic thing was purported to have a particular set of applications. Both movements raise questions about the notion of relevant expertise and relevant authority (see Shapin 2010, p387) and about how knowledge is made to move (see Secord 2004).

By once more drawing on historical precursors to his vision of the Anthropocene, Crutzen supported the sense that the Anthropocene belonged to stratigraphic investigation despite its coinage from outside that discipline. In this sense Crutzen performed a kind of work that Bruno Latour refers to as 'bringing friends in' in support of his claims (Latour 1987, pp 31-33; p54). Thus Crutzen's invocation of earlier works served to foster a sense that despite the off-the-cuff remark that precipitated the Anthropocene controversy, the term and the concept nonetheless represented a legitimate concept for stratigraphic consideration. Crutzen's use of these precursors also served to normalise the Anthropocene by demonstrating that the concept was previously given serious intellectual attention in the appropriate domain. Writing alongside environmental historian John McNeill in 2007 (Steffen, Crutzen & McNeill 2007) - and later alongside historian of science Jacques Grinevald in 2011 (as Steffen et al 2011a, pp 843-845) - Crutzen and Steffen took the list of Anthropocene precursors initially offered by Crutzen and filled them out with greater historical detail. In addition to Marsh, Stoppani, de Chardin, and Vernadsky, Crutzen and his co-authors added Joseph Le Conte and Édouard Le Roy as scholars who had contributed to an "invisible revolution" in thinking about the biosphere (p844; also Grinevald 2007, p22). These antecedents carried their own broader philosophical claims that may or may not be compatible with the argument that Crutzen wished to forward. For example, Bertrand Guillaume has elsewhere drawn attention to the metaphysical implications of Vernadsky's work as way to critique the hubris of geoengineering (2014, p144), the very same technological intervention that Crutzen seemed to support (2002; 2006). Despite the fact that these historical precursors could be mobilised in support of multiple contradictory agendas - indeed, Crutzen and his co-authors stress that these antecedents are "not equivalent to the Anthropocene" (Steffen et al 2011a, p845) - their deployment here nonetheless helped to scaffold the claims that Crutzen and his co-authors wished to forward.

As use of the Anthropocene expanded there was some heated debate over whether novelty or historical consistency served the Anthropocene narrative best. For example, environmental philosopher Clive Hamilton - a vocal and prolific supporter of the

Anthropocene - has consistently argued that ‘historical precursorism’ robbed the Anthropocene of its intended impact (Hamilton 2015a, p103). For Hamilton, the Anthropocene was a ‘rupture’ in the functioning of the earth system, and knowable only through that conceptual framework. Pairing that recognition with a long history of antecedents thus missed the point of the Anthropocene as a new observation that could only have emerged from an ESS perspective (see Hamilton 2014a; 2014b; 2014c; 2015a; 2015b; 2015c; 2016a; 2016b; Hamilton & Grinevald 2015; Hamilton, Bonneuil & Gemenne 2015). However, the use of these same historical precursors remained a touchstone for the Anthropocene controversy by stratigraphers making sense of the emergence of the concept from outside their discipline (Zalasiewicz et al 2011b, p1037; Zalasiewicz et al 2012b, p1033; Zalasiewicz 2013; Waters et al 2016). For advocates of stratigraphic formalisation these antecedents became a way to suggest that the Anthropocene was merely the “latest iteration” in a cycle of considering the impact of humans on the planet in terms of geology (Zalasiewicz et al 2011b, p1037; also Zalasiewicz 2013). Thus Crutzen had variously “restated” (Zalasiewicz & Williams 2014, p5; Zalasiewicz, Williams & Waters 2014, p39) and “resurrected” (Zalasiewicz et al 2011a, p835) those older arguments. The idea of ‘restatement’ in particular implied a belonging to geology and stratigraphy as if the concept had finally been returned to its proper place in the “technical sphere” (see Taylor 1996, p128) of geology. One member of the AWG with ties to the IGBP noted that these arguments helped to counter later criticisms that the Anthropocene concept had no meaningful relationship to geology or the discipline of stratigraphy (1x interview).

The second movement of Crutzen’s expertise raises questions about what this science was for. I noted above the oblique reference to a paper by Hans Joachim Schellnhuber in Crutzen’s second invocation of the Anthropocene in the journal *Nature* (Crutzen 2002). Schellnhuber’s paper posited a “second Copernican revolution” (pC19) in terms of human understanding of the planet in the form of earth system science (ESS). The first Copernican revolution saw the displacement of the Ptolemaic geocentric view of the ‘heavens’ and a shift to a heliocentric view of the solar system - here described as “[putting] the earth in its correct astrophysical context” (ibid). Evoking this powerful

metaphor, Schellnhuber's 'second revolution' similarly assumed greater explanatory power over the earth by understanding it "as a whole system." The strength of the earth system analysis posited by Schellnhuber lay in the value of 'EMICs' - earth-system models of intermediate complexity designed to overcome the two "fatal attractions" of earth system modelling; over-simplification and over-sophistication (pC23) - and computational analysis that could make sense of the planet's integrated geosphere-biosphere complex. However, beyond its explanatory power alone, Schellnhuber noted that ESS also "strives to understand and to develop, on this cognitive basis, concepts for global environmental management" (ibid). From the opening line that "[t]here are many ways of looking forward in time" (pC19) to the final paragraph and its invocation of "responsibility" (pC23), the language of the future formed an essential component of the logic of earth system analysis presented in Schellnhuber's article, and set up a neat contrast with stratigraphy's focus on the reconstruction of the geological past (Miall 2016).

As Schellnhuber argued, if the "research community does its job and develops a perfect hierarchy of transdisciplinary EMICs" then analysis would be obligated to take account of "the collective action of humanity as a self-conscious control force that has conquered our planet". This human component was expressed in Schellnhuber's model as 'S' in the equation $E=(N, H)$, in which 'E' is the earth system, 'N' the various planetary subspheres of the atmosphere, biosphere, cryosphere (and so on), and 'H' is the "human factor." 'H' was further expressed as a function of 'A', the 'anthroposphere' as the physical manifestation of human activities en masse, and 'S', "the metaphysical... emergence of a 'global subject' [that] manifests itself in... adopting international protocols for climate protection" (pC21). Like James Lovelock's Gaia Hypothesis - itself so crucial to the establishment of ESS (see Lenton 2016, pp 4-7; pp 137-144) - the Anthropocene appeared to be both "a metaphysic for interpreting the planet as well as a scientific legitimization for that metaphysic's plausibility" (Yearley 2001; p459). As one - later member of the Anthropocene Working Group noted - this in itself augured a challenge for stratigraphy, inverting the "historical, empirical bottom-up naturalistic approach" of stratigraphy and replacing it with the nomothetic "modelling and theoretical

top-down approach” of systems theory (1x survey). In a broader sense, ESS appeared as the new atomism for its advocates, a ‘metascientific claim’ (see McAllister 1992, p42) with aspirations to govern all knowledge produced about the earth.

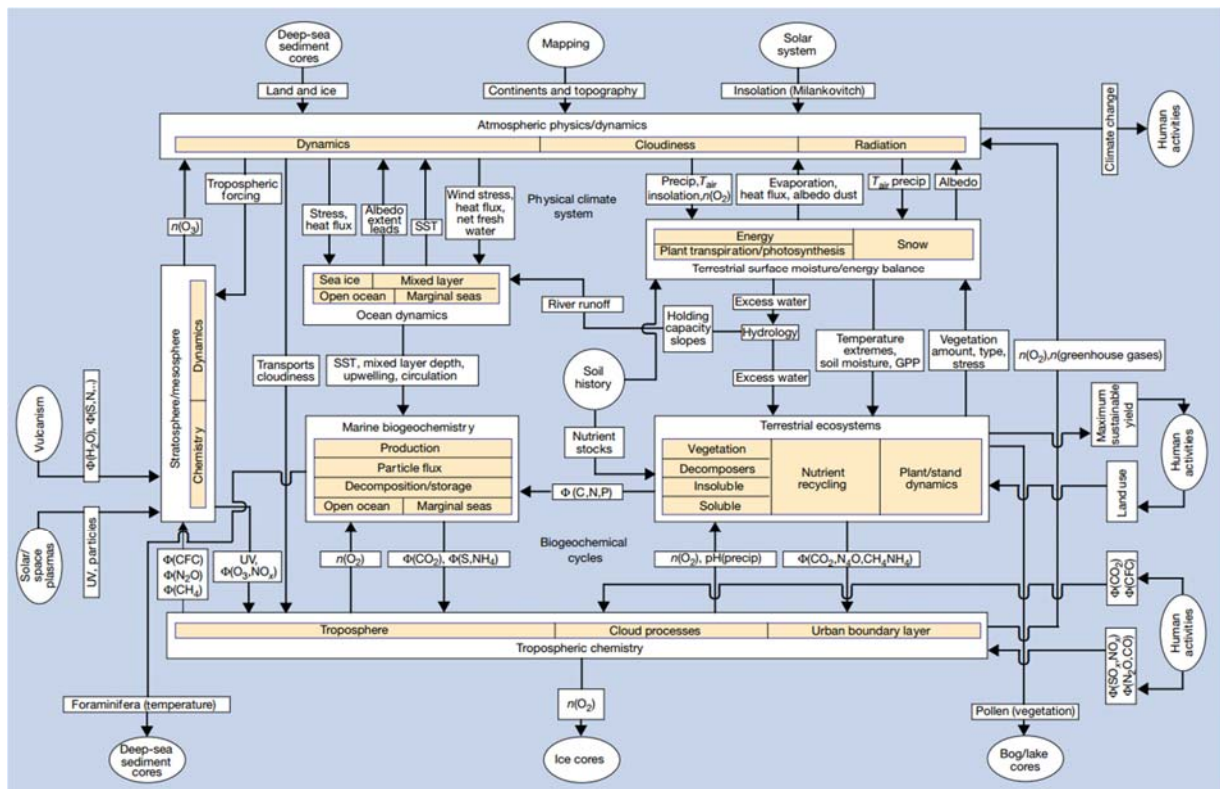


Figure 1: The “simplistic conceptual model of planetary machinery” that forms the basis of Schellnhuber’s “second Copernican revolution” (1999, pC21). Note the incorporation of “human activities” as a ‘blackboxed’ category on the far right hand side of the model.

Working through the IGBP, Steffen and his co-authors (including Schellnhuber, but not Crutzen) consolidated this vision of the earth as an integrated system in a special publication for the American Geophysical Union (as Steffen et al 2004). Despite the belief that humans were now overwhelming the earth system (Steffen, Crutzen & McNeill 2007; Steffen 2010; Steffen et al 2011a), the conceptual ‘blackboxing’ (see Latour 1999; see also Glanville 2009) of human activities to the far left of ESS’s conceptual map (Figure 1) confirm Schellnhuber’s earlier suggestion of a Comtean hierarchy about how knowledge was to be produced in this context. As one of the

authors noted of this work noted, because humans “are part of the earth system, the Anthropocene could be considered as a change wrought by the internal dynamics of [that] system” (1x survey). In a sense, this sentiment confirms the 'visual rhetoric' (Hullman & Diakopoulos 2011, p2239) of this conceptual model. The model might demonstrate an attendance to human activities, but the human subject responsible for those activities was nonetheless pushed to the margins of the page. Thus, despite the interest in the role of human behaviours, this was a context in which the contribution of the social sciences “[was] expected to be the provision of one element of an integrated analysis of the global environment” (Barry et al 2008, p36). Nonetheless, Steffen et al argued that “the planet is now dominated” by “multiple, complex, interacting” and “globally significant” human activities (2004, p14). The “magnitude, spatial scale, and pace” of this anthropogenic change was said to have driven the earth system into a 'no-analogue state' - no longer directly comparable to any past interval of earth history - which was to be called the Anthropocene. Like Crutzen’s earlier works, Steffen et al noted the huge increase in carbon dioxide and methane in the earth’s atmosphere. They also expanded their narrative of dominance to include the human appropriation of half of all accessible freshwater, 50% of the land surface, 40% of known oil reserves, and the fact that more nitrogen was now fixed synthetically than the sum of all natural fixing alongside the overexploitation of 22% of marine fisheries. In doing so, Steffen et al produced a sequence of graphs, later dubbed the ‘Great Acceleration’ graphs to “capture the holistic, comprehensive and interlinked nature of the post-1950 changes simultaneously sweeping across the socio-economic and biophysical spheres of the earth system” (see Steffen et al 2015, p86). These graphs served to illustrate the sharp acceleration of human activities across a range of measures from the 1950s onwards (Figures 2 & 3), and the associated concept of a ‘Great Acceleration’ would go beyond climate change alone to encompass Karl Polanyi’s 1944 treatise *The Great Transformation* and his forwarding of “a holistic understanding of the nature of modern societies” (ibid).

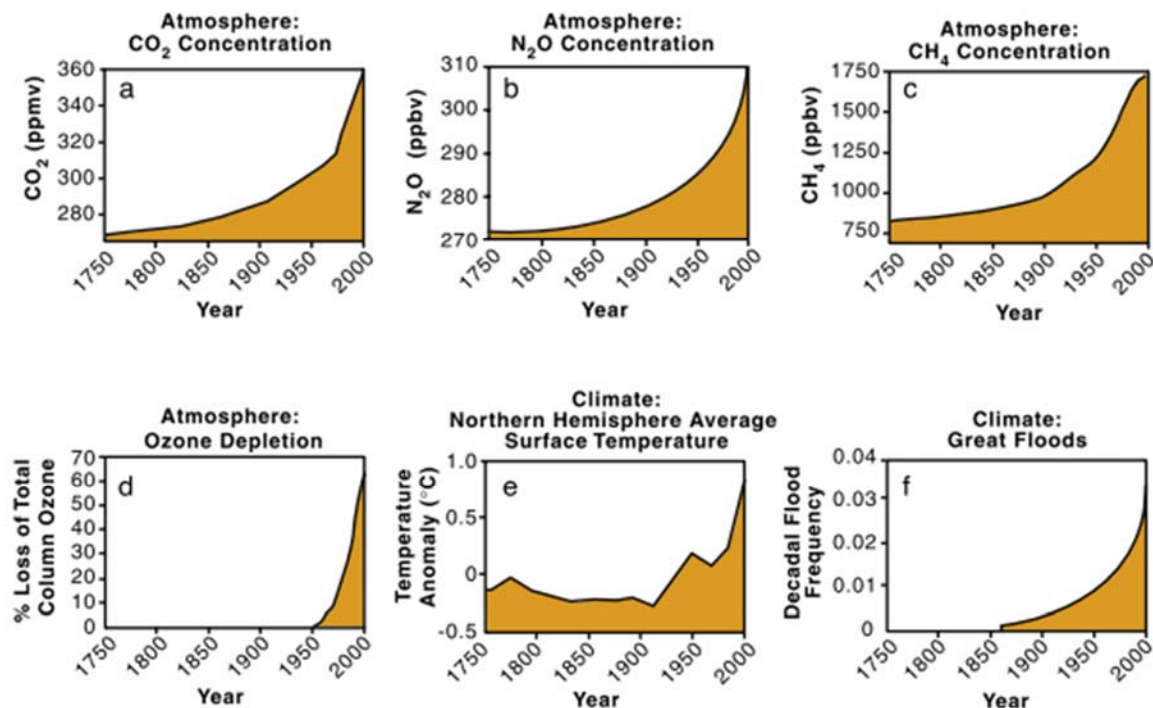


Figure 2: 'Great Acceleration' graphs for Atmospheric Carbon Dioxide, Nitrogen and Methane Concentrations, Atmospheric Ozone Depletion, Northern Hemisphere Average Surface Temperature, and Flood Frequency (Steffen et al 2004, p17).¹⁶

In order to produce this clear narrative of a sharp uplift in activities and impact across the earth system, these graphs combined largely disparate measurements and metrics, juggled linear and exponential scales, and mixed direct measures with indirect proxies (see also Bonneuil & Fressoz 2015, p70). The decision to aggregate all human activities as a single whole mirrored Crutzen's original decision to speak of the Anthropocene as the age of a singular humanity. As a result, these graphs drew direct criticism from commentators (for example Malm and Hornborg, 2014) and led to a later reissue - now stratified to show the relative contributions of the OECD, BRICS, and 'Other' nations - in

¹⁶ There were 12 graphs on page 17 of Steffen et al's article, these covered Atmospheric CO₂ concentration (ppmv), Atmospheric NO₂ Concentration (ppbv), Atmospheric CH₄ concentration (ppbv), Atmospheric Ozone Depletion (% loss of total column ozone), Northern Hemisphere Average Surface Temperature (°C), Great Floods (by decadal frequency), Ocean Ecosystems (as % of fisheries depleted), Coastal Zone Structure (as million megatonnes of farmed shrimp production), Coastal Zones Biogeochemistry (as moles of annual nitrogen flux), Loss of Tropical Rain Forest and Woodland (as % loss of 1700 values), Amount of Domesticated Land (as % of total land area), and Global Biodiversity (in thousands of species extinctions).

2015 (Steffen et al 2015, pp 86 - 91). Nonetheless, this sequence of graphics and their clear visual narrative helped to produce the basis for Steffen et al to argue the importance of ESS and the Anthropocene, and to further advocate for a system of planetary management that would respond to that science (p38). Working with the Executive Director of independent non-profit research institute the Stockholm Resilience Centre - Johan Rockström - Steffen and Schellnhuber were able to further consolidate their thinking into a series of 'guardrails' called 'Planetary Boundaries' that are now enmeshed within the institutional framework of the SRC and the IGBP's successor organisation Future Earth (Rockström et al 2009a; 2009b; Steffen et al 2011b; also Richardson et al 2009; van Kerkhoff et al 2011).

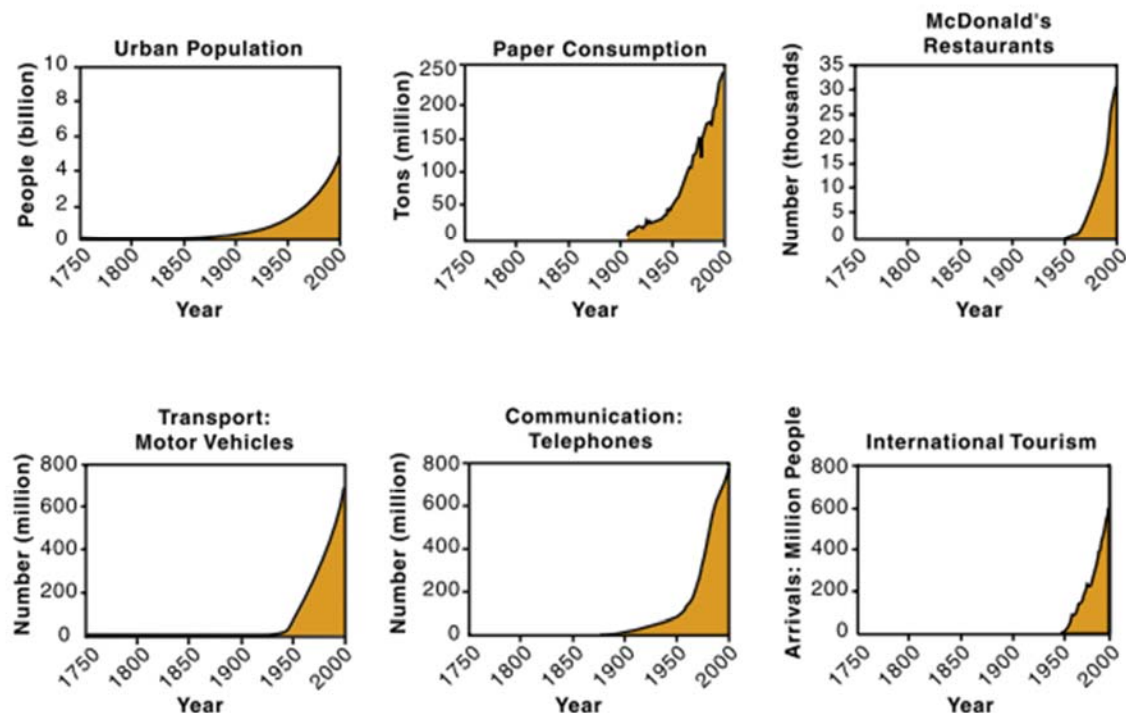


Figure 3: 'Great Acceleration' graphs for Urban Population, Paper Consumption, McDonald's Restaurants, Transport: Motor Vehicles, Communication: Telephones, and International Tourism (from Steffen et al 2004, p15).¹⁷

¹⁷ There were 12 graphs on page 15 of Steffen et al's article, these covered Global Population (in billions of people), Total Real GDP (in 1990 US dollars), Foreign Direct Investment (in 1998 US dollars), Damming of Rivers (as thousands of dams), Water Use (as km³/yr), Fertiliser Consumption (in millions of

These were highly international and outward facing efforts with a high premium on political impact. An infographic video called 'Welcome to the Anthropocene' developed by the communications officer of the Stockholm Resilience Centre was used to open the 'Planet Under Pressure' scientific conference that supported the Rio+20 United Nations Conference on Sustainable Development in 2012 and was introduced by then Secretary-General Ban Ki Moon. Much of the output of these bodies was channelled through communications officers who served as co-authors on a number of papers (for example in Seitzinger et al 2015; Steffen et al 2015; Gaffney 2016). As the communications director for both the SRC and Future Earth explained, these institutions had a strong focus on "thought leadership" for an audience of world leaders and "engaged publics" who "care" about the future of the planet (1x interview). These interests ultimately carried over to the formation of an *Anthropocene Magazine* intended to serve a similar market as *National Geographic* and *TIME* in autumn of 2016 (ibid; see also Revkin 2016). The institutional focus on outreach, alongside the availability of a dedicated budget for communications efforts, meant that the Stockholm Resilience Centre was able to capture the Anthropocene narrative in support of their own non-stratigraphic, sustainable development agenda. As a consequence, the first return on a Google search for 'Anthropocene' is the Stockholm Resilience Centre's own website (likewise) named 'Welcome to the Anthropocene'.¹⁸ Institutional interest in the Anthropocene in this context appeared to be less about the minutiae of the concept - or the controversy it had inspired - but more in the application of the "technical legitimacy" of a scientific sounding concept to provoke a political response (1x interview). Particular effort was directed towards the production of a term that - like DNA - everyone could recognise without necessarily understanding, and would serve to counter simple "soundbite culture" by intuiting a more serious conversation beneath (ibid). Following

tonnes of nutrients), Urban Population (in billions of people), Paper Consumption (in millions of tons), McDonald's Restaurants (in thousands), Motor Vehicle Transport (as millions of individual vehicles), Telephone Communication (as millions of individual devices), International Tourism (in millions of arrivals).

¹⁸ www.anthropocene.info. This website does in fact do a relatively good job of balancing various perspectives on the Anthropocene, especially after 2015 when it received a second round of funding (1x interview).

Crutzen's first writings, the fact of the Anthropocene - and what might be done with that fact - was thought to be more important than the relationship that concept may or may not have with stratigraphy. In reflection of this non-committal relationship to stratigraphy, work produced in this ESS-driven space described the Anthropocene in terms of a series of 'stages' that were shorter than the approximately 105 year minimum hypothetical resolution that can be detected through the application of accepted stratigraphic methods (see Miall 2016, p426). Thus the Anthropocene was broken down into a 'pre-Anthropocene' defined by local scale environmental perturbation (Steffen, Crutzen & McNeill 2007, p614), a 'first stage' coincident with the Industrial Revolution in Western Europe and defined in the most part by the release of vast quantities of greenhouse gases (p616), a 'second stage' predicated on the 'Great Acceleration' of a suite of human-driven processes (p617), and a metaphysical 'third stage' that assumes humans recognise the implications of the Great Acceleration and channel that newfound awareness towards "planetary stewardship" (p618). In this sense, for the community described above the epistemic thing 'Anthropocene' was in some sense spent. As Rheinberger notes, one possible end-point for an epistemic thing lies in its 'reification' or consolidation as fact (1997, p106). Satisfied that the scientific status of the Anthropocene was already well established, the concept was no longer interesting for this community as a research question. It had, in Rheinberger's sense, transmuted into a "tool" (ibid), one that allowed for this community to press forward and construct new research arrangements and opportunities in the more openly political field of sustainable development. Were it not for the controversy that later followed, this community likely would have been content to simply apply the Anthropocene to that end.

4.4. Paul Crutzen, Nobel Prize-Winner

Whatever their disciplinary status, Crutzen's early writings on the Anthropocene set up a diffuse intellectual agenda that invited a wide-ranging response. However, I think that the breadth of the Anthropocene that Crutzen sketched only serves as a partial explanation for the concept's rapid ascension. After all, Crutzen may have laid out an appetising spread, but this alone does not explain why scholars chose to come and sit

at his table. With this in mind it is important to recognise the role of individual, institutional, and institutionalised credibility in mobilising Crutzen's claims to an audience broad enough to incite a controversy. Thus Crutzen's prominent status in the IGBP, an institution with the resources to justify the publication of an in-house newsletter, comes to matter. After all, it was the fact that the Anthropocene was announced - in dramatic fashion - at this time and place that meant the IGBP's directors could commission an elaboration on the concept after Crutzen had first coined it. In this way Crutzen's network of 'familiar' - scientific practitioners who knew Crutzen well and in some sense needed his findings in order to further their own efforts (see Shapin 2010, p29) - ensured the concept received a second outing in *Nature*. By contrast to the remarkable spread of the Anthropocene, the 'Homogenocene' - a similar terminology conceived around the same time - that appeared to augur similar stakes for geology¹⁹ received only limited attention until commentators later drew it into the Anthropocene controversy by virtue of its superficial similarity (for example Palsson et al 2013, p4; Mann 2011).

Further, Crutzen's role allows us to recognise the role of contingency in the establishment of the Anthropocene controversy. Far from the semi-obvious 'fact' that the ESS community appeared to present, the importance attributed to Crutzen by interlocutors helps to illustrate the importance of a clear "mark of expertise" (see Shapin 2010, p313; also Taylor 1996, p128; Merton 1973) in making Anthropocene claims adhere. Authors that place Crutzen at the centre of the concept create a mythological 'moment of discovery' for the Anthropocene, a kind of 'eureka' moment that gave rise to the controversy as a whole. Thus, in positioning their own versions of the Anthropocene, interlocutors often returned to this moment and the dynamics that it established. It appears that recounting Crutzen's coinage was a necessary way to convey an expertise and legitimacy from which to launch any commentary on the Anthropocene. In effect, it was the fulcrum upon which to discuss the controversy regardless of intention, and a

¹⁹ Homogenocene similarly emerged from outside of stratigraphy and makes use of the metaphor of epochal change to highlight the magnitudinous impact of species invasion. The term was applied less literally (Samways 1999; Curnutt 2000), and because it was not tethered to any kind of obvious political response has seemingly far smaller implications than Crutzen's Anthropocene.

part of the cycle that afforded this moment its importance. The power and pervasiveness of this tethering of Crutzen and his status to the geological question of the Anthropocene even led to misinterpretations in the literature. For example, Valerie Olson and Lisa Messeri's exploration of the rhetorical topology of the Anthropocene controversy introduced both Crutzen and Stoermer as geologists (Olson & Messeri 2015, p28) despite this being strictly true for neither of them. Even accounts of the Anthropocene in critical scholarship struggled to move beyond this act of contextualisation (for example Baskin 2015, p9; Lorimer 2012, p593; Lundershausen 2015, p301; 2016; Lövbrand et al 2015, p211; Malm & Hornborg 2014, p62; Thornton & Thornton 2015, p66; Westcott 2015; Whitehead 2014, p1). Amongst critical accounts only Noel Castree (2014a, p436; 2014d, p234; 2017b) and Donna Haraway (2016b, p44) have acknowledged that Crutzen's particular status 'matters' and afforded it any kind of attention. In (re)telling this story across so many words I too have contributed to that mythologisation, an accidental consequence exacerbated by the unavailability of Crutzen to participate directly in this research. Nonetheless, I believe that there is value in establishing both the contingency of the moment and distribution of authority that made it so important for interlocutors in the Anthropocene controversy (Shapin 2010, p28; Barnes & Edge 1982).

It is clear in the literature and from my interview data that there remained long after 2002 a valuable currency in trading on Crutzen's particular status as a Nobel prize-winner, his eminence, and his fame when making the case for the scientific credibility of the Anthropocene. Just as Crutzen leaned into the authority of antecedent concepts to give his claims greater status, interlocutors in the controversy deployed Crutzen as a shorthand for the importance of the Anthropocene concept. This is true of writing in support of stratigraphic formalisation produced by the Anthropocene Working Group (Zalasiewicz et al 2008b, p4; 2011a, p835; Zalasiewicz 2013, p9; Williams et al 2009, p31), and of articles published outwith the AWG that supported the concept (Hamilton 2014a; Steffen 2014, 228). Crutzen's status seems to have had particular traction in press releases and media intended for the kinds of 'engaged publics' that were expected to act politically on the Anthropocene (Carey 2016; Gaffney 2016; Kolbert

2011; Revkin 2016; Sample 2014; Schwägerl & Bojanowski 2011; Solbu 2016; The Economist 2011; Vince 2011, p32; Voosen 2012). Given the intended audience for these works - a laity unable to assess specific claims about the Anthropocene for themselves (see Shapin 2010, p313) - Crutzen's Nobel Prize-winning status served to make visible the institutional authority that supported his invocation. He was not only a scientist, but also one in receipt of the highest public honour that a scientist can receive. Elsewhere, in strengthening their own arguments ecologist Simon Lewis and geologist Mark Maslin leaned into an invocation of Crutzen's intention, implying an alignment between their own arguments and his own (2015, p177). Likewise, prominent environmental journalist Elizabeth Kolbert went so far as to cite an unrecoverable private conversation with Paul Crutzen in order to profess a hard line to Crutzen's intentions and authority to validate her own argument that the Anthropocene be understood as "a warning to the world" (Kolbert in Romm 2014).

Even for the launch of Anthropocene centred journals it was seen as essential to have Crutzen on-board. As a member of the editorial board of the journal *The Anthropocene Review* noted, Crutzen's voice could lend the journal greater credibility, and to launch with both the support of Crutzen and an article penned by him would have given a first issue serious traction (1x interview). Such was the importance the journal attached to Crutzen as the embodiment of the Anthropocene concept that when he decided to join the editorial board for a rival journal - *Anthropocene* - it left *The Anthropocene Review* in disarray and scrambling "to pick up the pieces" (ibid). Elsewhere, when the University of Leicester decided to grant Colin Waters - secretary of the Anthropocene Working Group - the status of Honorary Professor, the associated press release made explicit reference to Crutzen as a way to vouchsafe Water's competence in the high regard held for him by Crutzen as a Nobel Prize-winner (University of Leicester 2016b). Elsewhere, as director of the IGBP Will Steffen drew attention to Crutzen's stratigraphic outsider status to suggest the overcoming of an institutionalised inertia within the discipline of stratigraphy (in Robin & Steffen 2007, p1694). In this way, Steffen supported the invocation of the Anthropocene as coming from Crutzen-the-individual specifically as he

was “a generalist working off a genuinely global canvas” and thus able to see the bigger picture (p1699).

Crutzen had value even where interlocutors disagreed with his particular interpretation of the concept. For example, some interlocutors leaned into the personal authority of Crutzen even where they considered him to have bent the rules of stratigraphy around his own personal vision of the concept. In effect, these interlocutors used Crutzen’s own loose deployment of stratigraphic language to license their own reinterpretations of the concept. For example, in offering their own novel interpretation of the concept archaeologists Bruce Smith and Melinda Zeder referred to Crutzen’s coinage as an “initiative” rather than a serious scientific proposal (2013, p8). This small rhetorical act helped to sever the link between the Anthropocene and any need to conform to the stratigraphic process. In a similar way, one participant in this research - a human geographer more interested in the metaphorical qualities of the Anthropocene than its putative stratigraphic implications - drew attention during interview to Crutzen’s inattentiveness to the particulars of the International Chronostratigraphic Chart to justify their own reconsideration of the Anthropocene in non-stratigraphic terms (1x interview). Likewise, other ‘politically’ motivated interlocutors - including an ecologist and a neom Marxist critic - pointed to Crutzen’s seemingly political ambitions for the Anthropocene during interview to justify their own politicised readings of the concept. For example, if Crutzen coined the Anthropocene with the intent “to awaken natural scientists to the fact that they should probably get out of their individual silos and try to understand coupled human-natural systems in order to understand global change,” as one suggested, then they and others could indeed argue that their own creative engagements with the controversy were in no way fundamentally different to Crutzen’s own (1x email; similarly expressed in 1x interview). These interlocutors acknowledged a “contingent” and non-scientific status for Crutzen (Burchell 2007, p160) and yet found value in him all the same.

Other interlocutors deliberately downplayed Crutzen’s specifically scientific authority to enhance the position of their own versions of the Anthropocene. For example,

geologists Stephen Gale and Peter Hoare paid very little attention to “Crutzen” and adorned him with no titles or accolades where they offered their own definition of the concept (2012, p1491). By refusing to acknowledge a particular status to Crutzen where others did, Gale and Hoare gave their own arguments greater relative weight. In a more pointed example of those staunchly opposed to the Anthropocene, interlocutors from the British Society for Geomorphology Fixed-Term Working Group on the Anthropocene tied Crutzen’s status as a Nobel laureate to a clear transgression of disciplinary expertise (Brown et al 2013a, p431). The Executive Chair of the International Commission on Stratigraphy matched this argument in a sharp criticism of the stratigraphic case for the Anthropocene (Finney 2016, p6), as did others who raised questions about the political implications of Anthropocene formalisation (for example Castree 2016a; Scourse 2016). One participant in this research - a Quaternary scientist engaged in broader debates around the value of formality in stratigraphic practice - dismissed Crutzen’s invocation of the Anthropocene and the importance given to the debate on the basis that similar terms have been around “for a long time” (1x interview). Their point was to suggest that if Crutzen possessed an appropriate expertise in stratigraphy he would have been aware that the Anthropocene - or at least its precursors - had not previously sustained serious intellectual interest amongst stratigraphers ‘for a reason’ (ibid).

4.5. Conclusion

This first empirical chapter has set the stage for the controversy to follow. Paul Crutzen created a concept and invested in that concept a set of meanings. Following Hans-Jörg Rheinberger (1997) I have understood that concept, the Anthropocene, as an ‘epistemic thing’, and established the parameters over which interlocutors later debated the concept. Rather than a set of new findings, Crutzen’s neologism represented the synthesis of a series of observations into a provocative new issue package (Lievrouw 1990), and his efforts - alongside those of his colleagues - resulted in the rapid spread of his concept. Crucially, Crutzen gave his vision of the Anthropocene a set of clearly defined political stakes. As a consequence, he not only positioned his concept at the

invisible cultural barrier that separates science from politics (Taylor 1996), but he also implicated the observational science of stratigraphy in that positioning. Despite the invocation of progress and a better understanding of the earth, the ESS vision of the Anthropocene established here was not simply out there to be discovered, but rather something made in part as a consequence of institutional status and networks (Shapin 2010). As a result, the Anthropocene established questions with far reaching consequences regarding authority, disciplinarity, and the movement of knowledge. Had Crutzen's term not carried such implications, perhaps the term would have had a less exciting history. As it stands, in granting his concept status and legitimacy, Crutzen made the Anthropocene belong to another discipline. If this new epistemic thing spoke to that discipline, then why didn't they come up with the term first? And, now that it was out there, what would they have to say about it?

Chapter 5: Epistemic Burden and the Establishment of the Anthropocene Working Group

5.1. Introduction

As I explored in Chapter 4, the Anthropocene emerged from a contingent moment: Nobel Prize-winner Paul Crutzen coined a provocative neologism on the fly, and due to his position of authority within a particular institutional setting was able to develop and expand upon this initial outburst to develop a more expansive concept. Crutzen's vision of the Anthropocene appears to have been designed to leverage the authority of environmental science, and stratigraphy in particular, towards political ends. As a result, the adoption and early spread of the Anthropocene raised a set of questions about the appropriateness of this new concept for stratigraphy, and about the role that such a concept was supposed to play in broader political discourse. In continuing this story this chapter does three things. Firstly, I describe the early stratigraphic response to the Anthropocene. This response - led by the Stratigraphy Commission of the Geological Society of London - initially hewed closely to Crutzen's own vision. Targeting UK parliamentarians, the group leveraged the notion of anthropogenic impacts of geological proportions to ask that political change be made. However, after these early forays the group produced an assessment of the Anthropocene for a dedicated audience of geologists. Secondly, I chart the consolidation of these early efforts into the formation of an Anthropocene Working Group, a dedicated investigative body operating under the institutional machinery of the discipline of stratigraphy. Despite a formal remit, the group grew through the amalgamation of expertise from both within and without the discipline of stratigraphy. The group's generous criteria for inclusion meant that this group was able to import the expertise of Paul Crutzen and the IGBP's Will Steffen, alongside a range of other interested parties. Finally, I discuss this move to establish a proper response from stratigraphy in terms of an 'epistemic burden'. Placed momentarily on the back foot by the emergence of a concept outwith their control, I argue that the formation of the Anthropocene Working Group in particular represented an unavoidable reckoning for stratigraphy. However, beyond a simple call and response, this epistemic burden

became a way for the group to illustrate the unique contribution of stratigraphy, and as a way to assert some measure of control over the proliferating use of the Anthropocene concept.

5.2. The Early Stratigraphic Response to the Anthropocene

As references to the Anthropocene began to increase during the period 2001-2006 (Figure 4), the members of the Stratigraphy Commission of the Geological Society of London began to acknowledge that scholars were using what appeared to be a new piece of geological nomenclature (1x survey). As one member noted, this presented a challenge because the term was being used in peer reviewed scientific literature “as if it were a formal stratigraphic term” when it was in fact not (1x interview). In this way, the adoption of the term by others raised questions amongst specialist stratigraphers in the Commission about how best to respond. As part of the Geological Society of London - the oldest such society in the world - members recognised that the Commission was an “appropriate venue” from which to initiate a preliminary investigation (ibid). Other members made clear during interview that the spread of the Anthropocene without the input of specific stratigraphic expertise left Commission members feeling a sense of responsibility to the discipline and its community of scholars (1x interview). As the Commission was composed of experts in the field, there was a shared sense that their preliminary discussions could bring an appropriate expertise to a concept that seemed to have clear “geological connotations” (ibid).

The Commission’s first publications were both short correspondences in the in-house journal of the Parliamentary and Scientific Committee parliamentary group, *Science in Parliament* (Zalasiewicz et al 2006; 2008a). In these correspondences the Stratigraphy Commission deployed the Anthropocene in a similar way to other early adopters of the term by using the Anthropocene to situate climate change within the “deep time context” of geology (2006, p2), noting how the rate and scale of climate change had led “some scientists to suggest, with all seriousness, that we have entered a new geological epoch” (ibid; similarly expressed in 2008a). While these articles did note the “[i]ncreasing

use] of the term [Anthropocene] by earth and environmental scientists” (2008a, p40), they did not focus on a discussion of the stratigraphic credibility or utility of the Anthropocene concept, nor did they mention the concept’s implications for the discipline. Rather, the Commission focused on the policy implications of rapid anthropogenic climate change. In particular, they admonished political inaction and argued that “the clear dangers of global warming are not currently being matched by adequate funding of either mitigation or adaptation strategies, nor by overall economic strategy” (ibid). In both articles the Commission urged consideration and political action. Much as Crutzen did in his first articles on the Anthropocene, the Commission deployed the notion of geological time and comparisons to past change to argue for a political response “commensurate” with the change that the Anthropocene “demands” (ibid). While the Stratigraphy Commission’s members argued that their response was triggered by the non-stratigraphic use of the Anthropocene in wider earth science literature (1x interview), these first public utterances suggest that the Commission, like Crutzen, recognised early the performative potential of the Anthropocene to encourage change along normative lines.

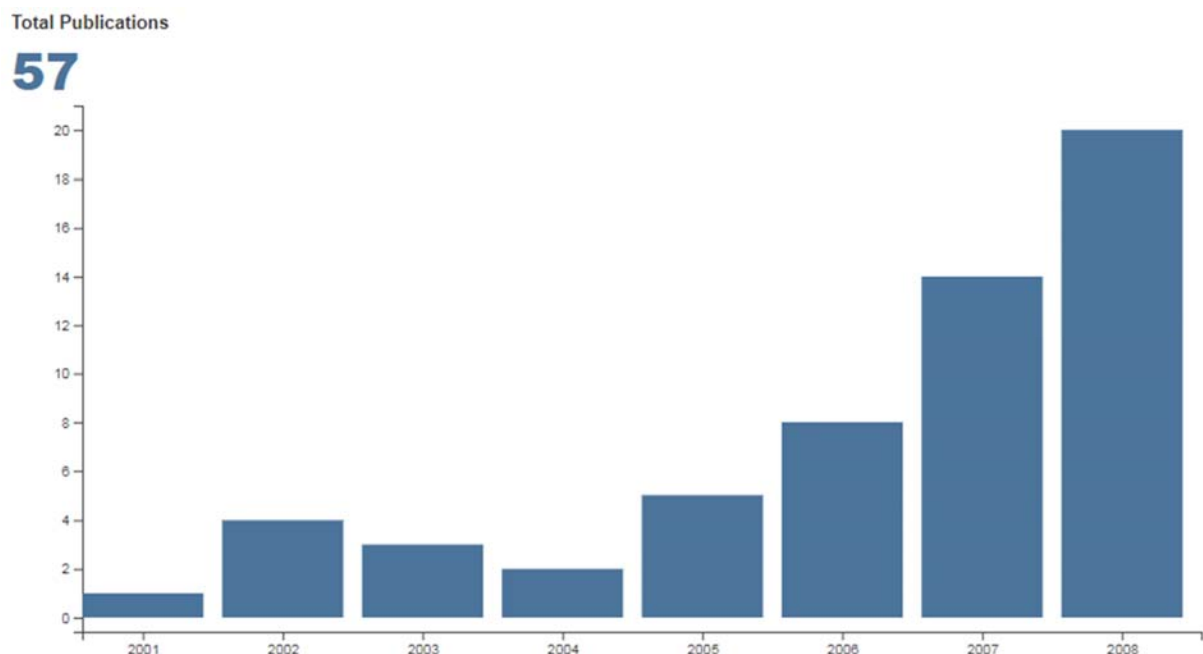


Figure 4: Web of Science chart of total publications including the word ‘Anthropocene’ between 2000-2008.

After further consideration, the Commission produced a more complete paper in *GSA Today*, the in-house publication of the Geological Society of America (Zalasiewicz et al 2008b). Unlike the Commission's two correspondences in *Science in Parliament*, this first complete and peer reviewed article considered the implications of the Anthropocene for the discipline of stratigraphy and was tailored towards a specific community of geologists. Crucially, the Commission made no explicit references to politics or policy import in this article. Instead, they asked whether "the effects referred to by Crutzen" were stratigraphically meaningful, and whether or not it might be possible to apply the "same criteria used to set up new epochs and whether there really was justification or a need for a new term" (p4). Further, the Commission briefly considered how and where stratigraphers might place a lower boundary for the Anthropocene. Rather than attempting to leverage the Anthropocene to encourage politicians to overcome inaction, the Commission assessed the term as a purely stratigraphic hypothesis. Unlike their proceeding efforts, the Commission wrote from a (nominally) evaluative position, albeit one that ultimately endorsed the formal ratification of the Anthropocene (p7). In so doing the Commission established three dynamics that retained importance for the stratigraphic assessment of the concept. Firstly, that informal use of 'the Anthropocene' as if it were a formal geological epoch must be answered with an appropriate stratigraphic assessment of the "utility" of the term (p4). Secondly, that there needed to be an assessment of the appropriateness of those stratigraphic criteria as regards this new question. And thirdly, that earth system science - here represented with reference to Will Steffen's (2004) exploration of global change and the earth system - would be crucial to this newly stratigraphic evaluation. Jan Zalasiewicz, a stratigrapher at the University of Leicester, led each of the Commission's papers. He was in some sense an obvious candidate for these efforts. Despite a different context and set of motivations, he had previously written about the possible stratigraphic legacy of human civilisation for lay audiences if sudden disaster caused the extinction of humankind in both the *New Scientist* (Zalasiewicz & Freedman 1998) and in a standalone popular science book called *The Earth After Us* (2008).

At this juncture I want to quickly establish the question of ‘appropriate’ stratigraphic criteria in response to the Anthropocene. As it stands, geological intervals are dated using either a Global Stratigraphic Section and Point (GSSP) or a Global Standard Stratigraphic Age (GSSA). A GSSP refers to an ideal stratotype of rock located in a specific place. GSSPs are typically marked with a physical plaque at a real world location and can be visited (see Figure 5). The GSSP refers to the rock and rock type, rather than the age. The aim of the GSSP system is to situate rocks of a certain type within an age band. By contrast, GSSAs refer to a numerical year. Where a GSSA is given, it is generally calibrated to the year 2000CE. Since 1977 the regulatory bodies of the International Chronostratigraphic Chart have suggested that all boundary changes beyond the Precambrian should be marked with a GSSP to aid global correlation (see Kranendonk et al 2008) as the presence of the rock material itself can be more effectively correlated across the globe than can absolute ages (Miall 2016). The Commission’s article in *GSA Today* however, argued that the application of a GSSP to the Anthropocene may have limited utility. While they were tentative in their conclusions, Zalasiewicz et al argued that “for current practical purposes” a GSSP might not be needed because both the resolution sought and the temporal proximity of the Industrial Revolution would create practical difficulties (p4). Given the “increasing use” of the Anthropocene - despite its informality - the switch to make use of a GSSA would allow for the selection of an appropriate lower boundary much more quickly and would allow stratigraphers to take advantage of the contemporaneous historical record. Zalasiewicz et al tentatively suggested the year 1800 because of the coincidence that this date has with Crutzen’s original suggestion that the Anthropocene began with the Industrial Revolution in Britain, and contended that in offering this date they would facilitate the “simple and unambiguous correlation” of both the “stratigraphical and historical record” and give “consistent utility” to the Anthropocene (p7). The Commission’s article not only appeared to set the stage for a more ‘liberal’ numerical age to be applied to the Anthropocene, but, in doing so, they applied a future orientation to the stratigraphic basis on which they proposed to rest their evidential case. Zalasiewicz and his co-authors explained that as a stratigraphic boundary, the Anthropocene would most likely be visible “from the perspective of the far future” (p4).

Because the change was “both elapsed and imminent” (p7) the article implied that the Stratigraphy Commission’s reading of the Anthropocene was at least partially grounded in a practice of speculative geology. That is, they drew an argument from both direct observation of human impacts, and modelling of how these impacts might unfold. Despite producing this article for a dedicated geological audience, the Commission did not mobilise any stratigraphic or sedimentological evidence in this article, instead positioning their intervention as a thought piece or a provocation for stratigraphers to take the Anthropocene concept seriously.



Figure 5: The GSSP plaque at the base of the Ediacaran Period in Ediacara, South Australia.

By suggesting that the Anthropocene be considered in terms of a numerical age, Zalasiewicz drew parallels to similar work that he produced outwith the Commission in favour of amendments to the division of geological time (Zalasiewicz et al 2004b²⁰). Zalasiewicz’s work in this area made a number of major contributions. Firstly, that the parallel systems of chronostratigraphy (the sequencing of geological material) and geochronology (the study of the age of rocks) was unnecessary and cumbersome, that the two systems were often used interchangeably, and were “not clear to the greater

²⁰ Zalasiewicz again returned to the question of calendar reform outwith the AWG and without reference to the Anthropocene in 2013 (see Zalasiewicz et al 2013).

part of the professional (or student) geological community” (2004b, p1). Secondly, reference to the age of rocks was often more precise and valuable than reference to geological material itself. Zalasiewicz et al argue that this preference for geochronology over chronostratigraphy was a consequence of the “kind of cross-disciplinary studies that now increasingly characterise geology” (ibid). That is to say, because crossdisciplinary scholarship often involved scholars who are less familiar with chronostratigraphic boundaries - but far more comfortable simply referring to the age of rocks - it made a certain sense to normalise stratigraphic nomenclature around this adjusted reality. Thirdly, that the increase in the technical and methodological apparatus available to stratigraphy - radiocarbon dating first and foremost - augured broader changes in the practice of the discipline. As Zalasiewicz et al noted, the “oft-quoted ‘holy trinity’ of rock, time, and fossils” need no longer apply to the contemporary practice of stratigraphy (ibid).

Instead Zalasiewicz et al suggested that a range of new measures like geochemical dating actually provided a more accurate description of change over time than did discerning patterns through the emergence of novel fossil assemblages. Finally, Zalasiewicz et al suggested that the literature base demonstrated wide-ranging slippages in the application of terminology in any case (p2). They suggested that the easiest way to redress this issue is to simplify the terminologies in play. Arguments for and against calendar reform have a long history in stratigraphy (for example Emiliani 1993). However, Zalasiewicz’s involvement in this concurrent debate created a potential conflict of interests regarding his involvement in the stratigraphic assessment of the Anthropocene. Because Zalasiewicz et al suggested that the Anthropocene could and should be decided on the basis of a numerical age or GSSA, Stan Finney - then Executive Chair of the International Commission on Stratigraphy (ICS) - and Lucy Edwards - the US Geological Society’s representative to the North American Commission on Stratigraphic Nomenclature - would later argue that Zalasiewicz could not perform a dispassionate stratigraphic analysis of the utility of the Anthropocene while simultaneously evaluating the criteria by which that stratigraphic analysis was to be conducted (Finney & Edwards 2016, p5). As a consequence, the questions that

Zalasiewicz raised in his considerations of calendar reform complicated the questions that the Commission he led addressed in their *GSA Today* article, because the Commission did not clarify whether they wished to assess the Anthropocene on the basis of existing stratigraphic criteria, or whether they wished to reshape existing stratigraphic criteria around the Anthropocene. In this sense the Commission's efforts illustrated a clear experimenter's regress (see Collins 1975) at the heart of the Anthropocene. As a group of stratigraphers, the Commission needed to simultaneously evaluate their evidence for the Anthropocene against their methods, and their methods against a body of evidence established elsewhere and to which they had already demonstrated some commitment.

5.3. The Establishment and Growth of the Anthropocene Working Group

The early consideration of the Anthropocene by the Geological Society of London was successful in so far as it provoked Philip Gibbard - a co-author on that preliminary assessment and more importantly the then Chair of the Subcommittee on Quaternary Stratigraphy (SQS) - to invite Zalasiewicz and the other co-authors to convene a new group (1x interview; 1x survey). This new group would operate under the auspices of the SQS, itself a constituent body of the International Commission on Stratigraphy. The ICS is a part of the International Union of the Geological Sciences (IUGS), an international body that promotes the study of geological problems and facilitates international cooperation in the earth sciences.²¹ While the Stratigraphy Commission could perform a preliminary assessment of the stratigraphic case for the Anthropocene in the interest of its members, the establishment of the AWG as part of the SQS represented the point at which the formal machinery of stratigraphy was mobilised in response to the Anthropocene. The job of the AWG would be to investigate the stratigraphic validity of the Anthropocene concept, and if they found it to be good, produce a formal proposal on which the members of the SQS, and the ICS could vote. If

²¹ As part of this remit the IUGS has the final say in the formalisation of new additions and amendments to the International Chronostratigraphic Chart (Miall 2016). It was suggested to me that in practical terms, however, the IUGS rarely questions the decisions made by the ICS, even though it is required to sign off upon them (1x interview).

those members reached a 'supermajority' of 60% in each instance, then the Anthropocene would be formally ratified and added to the International Chronostratigraphic Chart.

As chair of this new group, Zalasiewicz imported much of the Geological Society of London Stratigraphy Commission's core team. Colin Waters, Philip Gibbard, and Mark Williams all joined this new group. Because of the decision to bring over these members, their existing professional relationships, and their stratigraphic expertise, the leadership of the AWG viewed the group as a natural continuation of their previous efforts rather than something completely new. In this way, the AWG could similarly benefit from a "collegiate" and "tolerant" environment in which members could discuss things "amicably" and could "think aloud" (1x interview). However, while they might have previously had some leeway to ruminate on the political ramifications of the Anthropocene - as per their articles in *Science in Parliament* - the role of the AWG was defined in far more specific terms. Attuned to their new institutional context the first members of this new group recognised that their "sole function" would be a "[determination of] whether the stratigraphic signature of the Anthropocene is now sufficiently clearly defined to warrant its formal definition as a new period of geological time" (1x survey). In this way the AWG had to adapt to the more specific set of criteria that were the condition of their association to the SQS and the ICS. As another member noted, they had to work "straight down the line" to produce a completely neutral "objective" appraisal of the Anthropocene that would be strictly stratigraphic in character (1x interview). Because the ICS and IUGS carefully seek to guard their political neutrality, the kind of political lobbying that Zalasiewicz et al had earlier performed in *Science in Parliament* could lead to the head of the SQS asking the group to terminate their activities (1x interview).

After the establishment of the AWG the group's leadership made an effort to expand in order to account for both the emergence of the Anthropocene in ESS literature, and the need for scholars who might bring additional perspectives on contemporary global change. While the division of geological time is typically reserved for specialist

stratigraphers (Miall 2016, p312), the group appeared to have been torn by a somewhat contradictory disciplinary imperative to use “all available means” in the identification and calibration of geological boundaries (p344). Thus, from 2009 the AWG began to issue annual newsletters (AWG 2009 - 2017) as part of an effort to promote their investigation and encourage new members to approach them. Despite the need to produce a stratigraphic argument that would be “based on the rocks [alone]” (AWG 2014; 2x interviews) the group took on-board representatives of a wide array of disciplinary perspectives who were enrolled for their expertise in fields as diverse as ESS,²² sedimentology,²³ palaeoclimatology,²⁴ geomorphology,²⁵ tephrochronology,²⁶ geochemistry,²⁷ atmospheric chemistry,²⁸ landscape ecology,²⁹ meteorology,³⁰ petrology,³¹ tropical soil biology,³² oceanography,³³ palaeobiology,³⁴ palaeoecology,³⁵ archaeology³⁶ and landscape archaeology,³⁷ urban geoscience,³⁸ environmental engineering,³⁹ climate modelling,⁴⁰ science and technology studies,⁴¹ the history of science,⁴² environmental history,⁴³ environmental journalism,⁴⁴ maritime law,⁴⁵ and

²² Paul Crutzen, Will Steffen.

²³ Philip Gibbard, Michael Wagreich, Colin Waters, Jan Zalasiewicz.

²⁴ Ian Fairchild, Philip Gibbard, Irka Hajdas, Alan Haywood, Cath Neal, Victoria Smith, Mark Williams, Jan Zalasiewicz.

²⁵ Mike Ellis, Clément Poirier, Dan Richter.

²⁶ Victoria Smith.

²⁷ Andrew Kerr, Dan Richter.

²⁸ Paul Crutzen, Alan Haywood, Mary Scholes.

²⁹ Erle Ellis, Scott Wing.

³⁰ Carlos Nobre.

³¹ Andrew Kerr, Victoria Smith.

³² Mary Scholes.

³³ Juliana Ivar do Sul, Colin Summerhayes, James Syvitski.

³⁴ Clément Poirier, Mark Williams, Scott Wing, Alexander Wolfe, Jan Zalasiewicz.

³⁵ Anthony Barnosky.

³⁶ Matt Edgeworth, Irka Hajdas, Simon Price, Bruce Smith.

³⁷ Cath Neal.

³⁸ Simon Price, Colin Waters.

³⁹ Peter Haff.

⁴⁰ Irka Hajdas, Alan Haywood.

⁴¹ Jacques Grinevald.

⁴² Naomi Oreskes.

⁴³ John McNeill.

⁴⁴ Andrew Revkin.

⁴⁵ Davor Vidas.

sustainability research.⁴⁶ One article published by the AWG attributed the genesis of the paper to a “chance discussion between two of the authors over coffee” (Williams et al 2016, p49). While the majority of the AWG’s discussions were conducted by email, I think it is worth applying this sense of a coffee room conversation that drew in those who overhear it to the group as a whole. Indeed, as Chair of the group, Zalasiewicz appointed Mark Williams to serve as its first Secretary because Williams’ office was adjacent to his own at the University of Leicester (AWG 2009). While this informal character need not inhibit the group’s scientific efforts, Martin Rudwick has noted with regards to the Great Devonian controversy how traits like the self-selection of members and the lack of money can place limits on the kinds of work that scientists can be expected to perform (1985, p455). These are limitations of which some of the group’s more reflexive members demonstrated an acute awareness (1x interview; 1x survey).

In keeping with the global focus of the ICS the AWG made a clear effort to expand beyond its origins in London. Despite the group’s largely Anglophonic make up, there are members from every inhabited continent. Nonetheless, there was no formal mechanism for inclusion. Instead, invitations were extended as a consequence of existing institutional and professional working relationships and informal conversations at conferences (3x survey). Elsewhere, members asked to join the group after recognising commonalities with their own work considering the impacts of humans on ecological systems (1x survey). One member was candid about how they had come across the Anthropocene while searching for a concept in which to situate and contextualise their research to give it greater contemporary relevance (1x interview). After they had published, they were able to present their publication to the AWG as a sign of their engagement with the concept, becoming a member as a result (ibid). Another member - oceanographer James Syvitski who joined the group in 2014 - admitted in the AWG’s 5th annual newsletter that despite being one of the earliest adopters of the concept he “never had any idea of the profoundness of the term” and simply saw it as a “useful [way to] overcome [his] objections on limiting global environmental change to climate change science [alone]” (AWG 2014). In this sense,

⁴⁶ Erle Ellis, Reinhold Leinfelder, Simon Price, Mary Scholes.

membership was about reconciling what Syvitski was doing anyway, with a more grounded and stratigraphic approach to the concept on which he had already come to rely. This informal procedure for establishing membership and growing the group also led to the inclusion of a journalist - Andrew Revkin - on the grounds that they had previously used a similar term 'Anthrocene' when writing about environmental change in the 1990s (Revkin 2016, p63), and a maritime lawyer - Davor Vidas - who "reached out" to the group because of the role that the geology of coastal shelves plays in contextualising maritime law (1x interview).

The inclusion of these latter two members contributed to broader tensions with the SQS, where there was some concern that the group "wasn't focussing enough on the stratigraphic... [or] sedimentological record" (1x interview). Outwith the AWG, members of the British Society for Geomorphology Fixed-Term Working Group pointed to the inclusion of members like Revkin and Vidas as a sign that the AWG had been too generous in its selection criteria for new members (2x interviews). However, even beyond these two, membership was awarded for a variety of non-specialist reasons. For example, Revkin notes that it was a rogue tweet sent by economist Kate Raworth in October 2014 and later chased with a fuller commentary in *The Guardian* (Raworth 2014) decrying the lack of female representation that prompted the AWG to include more female members (Revkin 2016, online). As a consequence of the wide range of opinion and viewpoints the AWG accumulated into its membership, the group was markedly larger than other working groups in the ICS with as many as 35 members.⁴⁷ Those with and without prior experience with stratigraphic working groups recognised the AWG's size as indicative of its "extraordinarily different" character (3x surveys). The group's multidisciplinary base of expertise meant that members could likewise recognise how they were "unique" within the ICS (1x survey). Recognising that the AWG have been eager and enthusiastic to look at wider issues [than geology alone]"

⁴⁷ The AWG's 2014 *Newsletter* 5 puts the group's total membership at 35, as does the group's internal vote on the reality of the Anthropocene in the Summer of 2016 (University of Leicester 2016c; Carrington 2016), with one member suggesting the group had as many as 38 members (1x survey). Based on some members leaving and others joining, as well as the porous boundaries of the group, I put the maximum possible number of participants at 43.

(1x survey) critics in the (somewhat rival) Holocene Working Group⁴⁸ pointed to the need “keep bringing the thing back to geology” (1x interview; 1x email).

Despite the incorporation of new members from 2009, the AWG built on the Geological Society of London’s claim that the informal use of the Anthropocene needed to be addressed. Importantly, Zalasiewicz et al stressed the characteristics of that previous work in reaching such a conclusion. It was the very “independence” of the geologists at the Stratigraphy Commission, who developed their own response to the Anthropocene in terms of a “technical expertise in stratigraphy” - and not ESS - that led to the consolidation of the AWG (Zalasiewicz et al 2010a, p2228). They had declared, that there was indeed “stratigraphic merit” in further considering the Anthropocene as a putative epoch (ibid). However, while the AWG argued for the independence and the integrity of their investigation, articles produced by the group nonetheless regularly emphasise the role of others making use of the Anthropocene as a justification for their own consideration of the term. It was precisely the adoption of the Anthropocene “by practising scientists to denote the current interval of time” (ibid) and the quick and uncontrolled entry of the term into “the scientific literature” that justified their response (Zalasiewicz et al 2011a, p835). The AWG also pointed to the way in which the term had already been “widely disseminated in public media” and had entered the “vernacular lingua franca” of the social sciences, humanities, and arts to legitimise their own assessment (Zalasiewicz et al 2012b, p1033; also Zalasiewicz et al 2015b, p118). Thus, in consolidating their own contribution, the AWG identified three core issues in their analysis of the use of the Anthropocene. The first related to the lack of clarity over the formality or informality of this stratigraphic (sounding) concept in the literature, the second to the issue of a lower boundary or “base” and how and where this might be defined (Zalasiewicz et al 2011a, p835) and, the third to a lack of clarity over the hierarchical status of the Anthropocene. Despite Crutzen using the epochal suffix ‘~cene’, the AWG noted it was not clear from the literature whether the Anthropocene was being applied to mean that anthropogenic global change was indeed epochal in its

⁴⁸ Some of whose work took place concurrently to the AWG’s early efforts (Gibbard et al 2010; Walker et al 2012), and two of whose members - Philip Gibbard and (until he resigned from the AWG in protest against the direction of their investigation) Mike Walker - served on both groups.

extensivity. It may have in fact been lesser - an 'age' - or greater - a 'period' or an 'era' (ibid; also Wilkinson et al 2014, p185; Zalasiewicz & Williams 2014).

5.4. The Anthropocene as an Epistemic Burden for Stratigraphy

In his critical examination of the parameters of the Anthropocene controversy, Johannes Lundershausen argues that if Crutzen had given the Anthropocene a different name - one that did not imply a relationship to stratigraphy - the controversy may have played out differently (2015, p318). As Lundershausen notes, counterfactual arguments may be analytically limited, but had Crutzen named his argument for the emergence of a new species - for example 'Homo geologiae' - Crutzen may not have provoked interest from the discipline of stratigraphy. There is an International Commission on Zoological Nomenclature, but Lundershausen contends that their regulatory role is less pronounced than that of the International Commission on Stratigraphy (ibid). Expanding on Lundershausen's argument I suggest the response of the stratigraphic community to Crutzen's new term should be understood as a consequence of an 'epistemic burden'. This epistemic burden refers to the need for the AWG acting on behalf of the discipline of stratigraphy to return the Anthropocene - emerging from outside the discipline but with an implied relationship to it - to their domain. Counterfactual arguments aside, the fact of the matter is that Crutzen did give his epistemic thing a geological sounding name.

As James McAllister notes in his discussion of the cold fusion controversy, a large part of the dynamic between the counterclaims by both physicists and chemists over the veracity of the claims being made about the possibility of cold fusion need to be understood as a part of a larger tension that existed between physicists and chemists (1992, p23). In that sense, tension was not only about whether the claims being made were true or false, but also about the intrusion of one discipline into the domain commonly thought to belong to the other. Thus, when a pair of chemists began to make claims about fusion, an area that physicists typically understood to be 'their' domain, it was understood by the physicists to be an implicit attack on their expertise and their

mastery of their own discipline. If the chemists were right in their claims, it was not simply the case that this new knowledge had been generated and could be appended to what the physicists already thought they knew about fusion, but rather that the physicists had missed something crucial. They would be deficient in their very understanding of what fusion was and the ways in which it might be investigated and understood (ibid). If that were the case then chemists would usurp the carefully constructed authority of physicists to speak for fusion. In the same way, the emergence and spread of the Anthropocene from outside of the discipline of stratigraphy goes beyond a simple contest over the factual status of the claim that the earth had entered into a new epoch of geological time. Rather it was about the credibility and status of stratigraphy and its ability to respond to those claims whether they ultimately proved to be true or false. It is this need to respond and return a stratigraphic-sounding concept to a more appropriate “technical sphere” where necessary expertise could be brought to bear (Taylor 1996, p128) that I call an ‘epistemic burden’.

Far from a simple question of responding to a term that had begun to establish itself outwith the discipline, this epistemic burden resonated in complex ways. Earth system scientists - and others - might have had it “already” (1x interview) but because the Anthropocene was already being used outside of the discipline, outwith and prior to a formal reconciliation, AWG members recognised that the utility of the term had already been demonstrated elsewhere (2x surveys). As one member noted, “the concept of the Anthropocene [had] already proved its worth in the wider world [by] opening up a multidisciplinary debate on planetary-scale issues” (1x survey). In a sense, these interlocutors had demonstrated what Steven Shapin calls a ‘prudential expertise’ (Shapin 2010, p311) by recognising the geological implications of such profound global change, even if they did not necessarily understand the stratigraphic process when making their claims. That is, even if the version of the Anthropocene established by the ESS community had little to do with the particulars of stratigraphy, those scholars had demonstrated that the Anthropocene indeed had value - even it had yet to undergo scrutiny from a strictly stratigraphic perspective - and could not be rejected out of hand. In response, the AWG - acting on behalf of the discipline of stratigraphy - was to

demonstrate a superior 'ontological expertise' in the phenomenon. In effect, stratigraphy alone "could penetrate behind appearances to hidden realities" and establish a definitive conception of the Anthropocene (ibid). As one palaeobiologist member noted:

From the mere scientific perspective, if the myriad planetary changes that the Anthropocene captures is not formalised, then it decries a serious doubt in the scientific aptitude of stratigraphy to truly identify key changes in the earth system and their geological ramifications! This portends poorly on our collective skills to interpret deeper earth history.

(1x survey)

Following a similar line of argument, another member of the group - a paleoclimatologist familiar with the impacts of humans on the planet as a result of their own research into long term climate variability - suggested that the AWG had not only to prove that they could also recognise the changes being labelled 'the Anthropocene', but that they were not in some way deficient in their understanding of those changes (1x survey). Because the term Anthropocene implied a relationship to their area of expertise, members could recognise the risk that failure would leave stratigraphy displaced from a conversation that was already taking place without them (1x survey). In this way the Anthropocene augured potentially serious material consequences for the discipline - much as the cold fusion controversy did for the discipline of nuclear physics - and stratigraphers within the AWG could sense how a 'failure' to formalise could be seen as "the geological community questioning the magnitude of anthropogenic change" (1x survey).

Simultaneously, members of the AWG retained an awareness that they were responding after the fact of the Anthropocene's spread and that the term could never really belong to them as a group, because "the term had already gained wide acceptance and interest in the communities dealing with ESS and environmental science and Holocene geoscience" (1x survey). The sense that a formal stratigraphic Anthropocene might actually contribute very little to a discourse that had escaped the

ability of the AWG to control risked undermining the very reason for the group's establishment. Formalisation might boost usage of the Anthropocene, but for those members who had joined the AWG from outside of the discipline of stratigraphy there was a sense that the group had done enough by simply helping to legitimise the Anthropocene in stratigraphic terms and gift it "greater currency" (1x survey; 1x interview). That the possibility of losing control of the controversy did not undermine the AWG's very reason for being was perhaps due to the broadly unreconstructed view of the role of stratigraphic formalisation in what the group set out to achieve. The AWG recognised that formalisation matters to geology for its role in both enabling, and stabilising the effective correlation of research performed in different times and places (see Miall 2016; also 1x interview). However, beyond confirming the (already established) reality of anthropogenic change it was only because formalisation matters for geology that formalisation of the Anthropocene was understood to matter by the AWG. As one AWG member with a joint role within the broader SQS noted:

A stratigraphic definition is more-or-less required for the Anthropocene to be included as a formal unit of geological time.

(1x survey)

In this way the question of whether the Anthropocene needed to be formalised at all remained conspicuously unanswered in the corpus of literature that the AWG and its members produced. Accepting the reality of anthropogenic global change and its possible geological implications from the start, the AWG did not in print or during interview suggest that they ever considered the Anthropocene from the other direction, by asking why others were using the term and exploring whether it might be more appropriate for other scholars to stop.

By arriving 'late to the party' as such, the implication is that stratigraphy had failed to recognise something others had spotted for themselves (see Shapin 2010, p291). Thus, failure would not only serve to delegitimise the value and visibility of an otherwise "terribly obscure" discipline that had the necessary tools to meaningfully ground the

Anthropocene concept (1x interview), but it would also loosen the authority with which the discipline might seek to assert control over its own terminological apparatus. This concern was perhaps exacerbated by the decision to bring in a range of non-stratigraphic experts who had already assigned meaning to the Anthropocene and were treating the Anthropocene as a “real thing” already (1x survey). Aware of what this might imply for stratigraphy, the AWG’s leadership implied a sense that it should be stratigraphers who decide the outcome of decisions on the appropriate use of their nomenclature set (1x interview). If they could not take back control of that naming process, the discipline of stratigraphy would cede their ‘epistemological superiority’ (Lessl 1996, p382) to another discipline and effectively concede that another practice had better explanatory power over the world. They would be forced accept a passenger status with regards to the Anthropocene concept, and accept whatever definition was reached without their input. Conversely, successful formalisation became a vehicle for legitimising both the stratigraphic process - with its arcane and hierarchical institutionalised forms - through a new set of conceptual problems, and as a litmus test for the potential role and place that stratigraphic expertise might play in the study of contemporary global change. Without the offer of formalisation, stratigraphy actually had very little to offer those who were already using the term. However, the prospect of stratigraphic formalisation - wholly contingent upon Crutzen’s giving the Anthropocene a stratigraphic name and yet “truly unique” to stratigraphy (Miall 2016, p2) - meant an opportunity to preserve the ‘uniqueness’ (see Taylor 1996, p172) of the discipline. In short, formalisation allowed the AWG to go beyond a simple confirmation of something already held to be true elsewhere, and instead put a particular stamp upon that knowledge.

Successful formalisation would also mean a kind of control. In evoking the use of the Anthropocene by communities as diverse as the humanities, arts, the media, policy makers, and the layman on the street some members of the AWG made it clear that they wanted to act on behalf of “all [of these] communities” in their attempts to offer a rigorous definition for the Anthropocene (2x surveys; also Zalasiewicz et al 2015a, p196). As a practising stratigrapher concerned about maintaining clear definitions so

that they might know whether sedimentary material falls within a particular interval, one member made it clear that the prospect of formalisation served to ensure that “only one definition of the term [Anthropocene] is used” and to avoid unhelpful “woolliness” (1x interview). This single definition was contrasted to a situation in which interlocutors are free to implicate the stratigraphic process where they wish to have other conversations that moved beyond that which is recognisably stratigraphic in character (ibid). One member of the AWG who held a number of institutional roles across the SQS and the Holocene Working Group implied less far-reaching implications for the group’s efforts by suggesting that their work would primarily impact upon the geological community alone (1x interview). Nonetheless, even they noted the difficulty of setting a boundary on the limits of their responsibility towards the term. As this member pointed out, it was others and not they who had entered into the domain of another discipline (ibid). While some of those interlocutors may have done so without consideration of the implications that their actions might have for stratigraphy, unawareness did not prevent the adoption of the Anthropocene by such scholars from forming a kind of disciplinary transgression. In this sense, the AWG simply wished to standardise the use of the International Chronostratigraphic Chart in response to a new concept, and this simply carried obligations for those who wished to - knowingly or unknowingly - evoke that scale in making their own arguments (ibid). As a consequence, some members suggested that should their efforts ultimately lead to the ratification of a new epoch, then the literature that made use of the Anthropocene would need to “reappraise” its usage of the term in the light of the proper definition that they would offer (1x survey). In suggesting that formalisation might have its most significant impacts outside of geology some members of the AWG acknowledged that formalisation would actually facilitate those broader conversations (1x interview). In this way the group’s epistemic burden formed a kind of productive tension between response and control. I think that in the spirit of open and productive debate the members of the AWG actually wanted people to use the Anthropocene more, so long as that usage conformed to “at least one” relatively clear common definition (whether formalised or not) that recognised the role of stratigraphy in mediating on the use of stratigraphic nomenclature (2x interviews; 1x survey). A rigid definition might limit the interpretive flexibility of the term, but for some

stratigraphers in the group decisions about how loosely or rigidly a stratigraphic term might be applied were for stratigraphers to make.

5.5. Conclusion

In this chapter I have described the early response of the stratigraphic community to the 'epistemic burden' created by Crutzen's invocation of the Anthropocene. Like Crutzen's earliest writings, early stratigraphic responses sought to leverage the geological magnitude of anthropogenic change to provoke a political response. However, when the Stratigraphic Commission of the Geological Society of London produced their first truly stratigraphic argument for the Anthropocene they dropped this explicit reference to politics. This first more complete analysis was successful enough to prompt the establishment of a dedicated Anthropocene Working Group that would operate under the auspices of the formal institutional machinery of stratigraphy. Despite making no reference to politics, this analysis nonetheless raised a set of challenging questions about whether the group wished to assess the Anthropocene based on existing stratigraphic criteria, or whether they wished to reshape those criteria around the Anthropocene. The AWG's efforts have much to do with 'epistemic authority' (Shapin 2010; Gieryn 1999; Taylor 1996; Lessl 1996; McAllister 1992), with the group acting on behalf of the stratigraphic community to exert control over a concept that had been given meaning and granted familiarity by others and yet carried implications for their own practice. However, despite accepting a purely stratigraphic remit, the AWG also expanded to incorporate members from a range of non-stratigraphic perspectives. Taken alongside the implicit politics of their response and the experimenter's regress (Collins 1975) at the heart of their analysis, this decision to range far and wide in terms of multidisciplinary expertise suggested a complex set of motivations for the AWG's efforts. It suggests that in their efforts to fully grasp the Anthropocene concept the group wished to perform both a purely stratigraphic investigation and whilst incorporating additional expertise. In this chapter I have shown how members of the AWG were willing to rally around this epistemic burden and provide a stratigraphic response to the Anthropocene. In the next I will explore the ramifications of the group's multidisciplinary

membership and expertise. Beyond a simple burden of how to respond to claims made elsewhere, the question for their science was not just who owns it, but what it was for.

Chapter 6: Multidisciplinary Tension and the Role of the Anthropocene

6.1. Introduction

In the previous chapter I traced the response of the stratigraphic community to the epistemic burden presented by the adoption and spread of the concept of the 'Anthropocene' through to the establishment of a dedicated Anthropocene Working Group. In this chapter I build on that narrative by exploring the effects of the AWG's expansive membership on their investigation. In the first section of this chapter I consider how the AWG negotiated and internalised their multidisciplinary membership in the face of external criticism. As Andrew Miall notes in his comprehensive *Stratigraphy: a Modern Synthesis* (2016) stratigraphy in its modern form might be the discipline that "pulls everything together" (p311), but the inclusion of non-stratigraphic members and new data sets created challenges for a practice used to reconstructing narratives of earth history from a paucity of data. Despite these challenges, the AWG ultimately embraced elements of a process-driven ESS vision of the Anthropocene, built upon the possibility of modelling and speculating on an open-ended future. These concessions to the vision of the Anthropocene first presented by Crutzen have potentially large ramifications for stratigraphy, a practice historically defined by the observation of existing strata (Rudwick 1988; Oldroyd 2003). Were the AWG to successfully make the case for the formalisation of the Anthropocene they would have fundamentally inverted the practice of the discipline. In the second section of this chapter I consider how the AWG's more-than-stratigraphic conception of the Anthropocene saw them reintroduce an explicitly political statement to their efforts. Members came to recognise the potential for stratigraphic formalisation not only to validate the reality of the Anthropocene, but also as a way to side-step political debates about anthropogenic climate change. Despite members' growing sense of a political mission for the Anthropocene, the group nonetheless sought to present their arguments for stratigraphic formalisation without reference to the political dimensions of their thinking. Recognising that the boundary between scientific observation and intervention is complex and subject to debate, the group's decision to do so raises questions about the role of scientific authority in political

debate. Should their bid for formalisation ultimately be successful, they would not only have changed stratigraphic practice, they would have politicised the discipline.

6.2. Negotiating Multidisciplinarity in the AWG

For the members of the AWG, the multidisciplinary nature of their efforts provided a number of self-evident positives. Irrespective of their own personal disciplinary backgrounds, members noted how the Anthropocene drew together geological, archaeological, and historical timescales alongside instrumentally recorded time in a way that was reducible to none of the above (1x interview; 3x surveys). In this sense, members suggested that as an object of investigation the Anthropocene not only necessitated such an approach but that it could serve as an excuse to work on synthesising a range of approaches in the interests of ‘interdisciplinarity’. Specialists in the group noted how a multitude of perspectives made the AWG a “wonderful place to fly and debate new ideas” (1x survey) and an “inspiring” place to learn from the representatives of other disciplines (1x survey). This view was part of a broader sense in the group that despite their strict stratigraphic remit they were able to recognise some of the broader science, social science, and political ramifications of the Anthropocene as part of a desire to recognise the utility of the concept for others (3x interviews; 2x surveys). As one stalwart stratigrapher in the group noted, because the Anthropocene “[steps] on the toes” of these disciplines the group needed to foster a policy of inclusivity lest those disciplinary communities react negatively were they presented with a singularly stratigraphic assessment and not allowed to feed into its development (1x interview). Recognising this as a virtue, one self-perceived outsider in the group suggested that it was a “real credit to the group” that even they be given time and space to discuss their often contrarian views (1x interview).

However, while the group had expanded to account for the Anthropocene by drawing in multidisciplinary expertise, this expansion created a challenging “tightrope effort” for the AWG’s leadership who were forced to balance this breadth against their stratigraphic remit and their desire to produce a “fundamentally classical” assessment of the

stratigraphic evidence (1x interview; 1x survey). One member - whose expertise meant they were more familiar working with the deep geological past - noted how the “presence of scientifically literate humans” able to both observe and influence global change complicated the role of stratigraphy by encouraging the group to look beyond the sedimentary findings alone (1x survey). Other members also understood that the group possessed a “wider skill and expertise base than... normal” (1x survey; similarly expressed 1 further survey). Thus, in making sense of their eclectic membership some members of the group appear to have considered their efforts in terms of an “opportunity” (1x interview). Instead of relying on proxies to reconstruct a fragmentary record of an unknown past - as stratigraphy has historically been used to do (Miall 2016, p343) - the Anthropocene represented a chance to “integrate the historically documented evolution of [the] planet with its geological response” for the first time (1x survey). As stratigraphers on the group were keen to point out, their aim was not to undermine the basis of the discipline in discerning patterns out of rock (1x interview; 1x survey), but simply to recognise that “there are other things to be considered” beyond the sedimentary record alone (1x interview) and that “historical records and observational data” could “[enhance the] available dataset” while presenting a better overall picture of the Anthropocene phenomenon (1x survey). By contrast, for some in the AWG these new data sources and the prospect of modelling observed impacts in real time meant inverting the ground up, empirically driven approach of the discipline (1x survey).

In this way the Anthropocene became a “hopeful monster” for a group whose diverse membership drew their understanding of this epistemic thing from a range of perspectives, and an opportunity to test the epistemic limits of stratigraphy. For those members invited into the group their very inclusion served as a tacit endorsement of this extended remit. Coming to the group from outside of stratigraphy and recognising that the concept was already well developed in other contexts, some members noted that it would have been impossible to open the door to such a great range of perspectives without those perspectives having an impact on the group’s practice (1x survey). In this sense, the group’s “interdisciplinary composition” was a chance to press “the historical

and epistemological development of stratigraphy” beyond the group’s official task of preparing a preliminary assessment of stratigraphic arguments (ibid). Even those stratigraphers in the group with greater familiarity of the functioning of the working groups of the ICS noted an informal extension to the group’s activities that was “not strictly part” of their “limited remit” and yet was fundamentally invited by the challenge of defining their purpose (1x interview). Despite the group’s desire to produce a stratigraphic response to the epistemic burden on the Anthropocene, they seemed torn by the prospect of producing something more novel. The group’s multidisciplinary dynamics meant not only producing a better account of the phenomenon of the Anthropocene, but it meant an opportunity to overcome the ‘disturbing’ “academic apartheid” between the natural and the social sciences that excluded the study of the human species from natural science thinking (1x survey; 1x interview).

This pressure manifested itself in various ways. For example, the group clearly believed that the availability of greater precision and higher granularity offered by new sources of data created an expectation that they could, and should, provide a startlingly high level of precision when offering to settle the lower boundary question (1x interview). As the AWG began to accept Steffen’s ‘Great Acceleration’ as the logical onset of the Anthropocene, they actually considered 05:29 on the morning of July 16, 1945 at the exact moment that the Trinity bomb was detonated in the New Mexico desert as a putative start point for the Anthropocene (Hancock et al 2014; Waters et al 2015). However, such fine resolution presented challenge for a discipline more familiar with error bars in the tens of thousands and millions of years (Renne et al 2013; ICS 2013) and the fundamental incompleteness of the stratigraphic record (Miall 2016, p343). In this way the paucity of data that had historically defined the discipline was inverted into a hyper abundance of data leaving the “noise greater than the signal in many cases” (1x interview; 2x surveys). As one member noted, the arrival of increasing accuracy placed pressure on this system of global correlation, leading to the “inevitable need to tweak the system, or to adjust it” to account for the increasingly precise divisions that techniques like radiometric dating enable (1x interview). However, the push to incorporate the historical record and pin a geological boundary down to the exact

second was at odds with the broader culture of stratigraphy which might strive towards greater resolution, but had never been required to deliver it quite so dramatically.

This pressure on greater resolution generated other challenges for the AWG's thinking, because their investigation began to illustrate how the obvious boundaries between geological divisions begin to disappear and become harder to identify properly where there is an overabundance of evidence. Where boundaries had traditionally been placed comfortably "where nothing has happened," the spectre of stability between periods of upheaval has all but disappeared from the contemporary interpretation of the International Chronostratigraphic Chart (Miall 2016, p344). Increasingly high resolution analysis has left questions about how representative any given sample can be when scaled up to speak for geological time writ large (p2). As a result, one experienced member noted, increasingly the discipline has had to learn to "compromise" on the placement of golden spikes (1x interview). For those AWG members who were already comfortable with this more recent and granular dataset such a change was welcome, and one noted the disingenuousness of thinking of "the emergence of human processes as happening quickly, [when] it [actually] happens relatively slowly" (1x interview). While a remarkable abundance of data might make it technically feasible to locate an exact boundary for the Anthropocene, to do so actually served to obscure the much longer history to that change, giving no insight into the 'thick stuff' that might tell us how and why that change came about (ibid). One prominent stratigrapher in the AWG noted sympathy for this view, but also noted that a long and detailed narrative fell beyond the remit of the group and the role that stratigraphic formalisation was intended to play. A long narrative might reflect better the history of anthropogenic changes, but could not be used to produce a clear stratigraphic boundary that could be recognised across the globe (1x interview). In this way some members found themselves sympathetic to the kinds of longer term narratives of change coined in the broader controversy⁴⁹ that were built around earlier onsets than the AWG's own later 'Great Acceleration' consensus position. While these options each had "problems", particularly regarding their failure to

⁴⁹ I explore the multiple alternate start dates to the Anthropocene offered outwith the AWG, and their role in the controversy in the next chapter.

produce a single isochronous onset, members were sympathetic precisely because humans were clearly having an impact at that time (ibid). Thus, these earlier options were not at fault per se, and neither was the discipline of stratigraphy mistaken (ibid). It was simply the case that this epistemic thing and stratigraphy found themselves at a disjunction over their approach to the same material. However, in offering a more critical perspective, one member suggested “it’s an obsolete idea” that the group might discuss that longer history and then dismiss it from their final analysis by professing to offer such a precise start date for the Anthropocene (1x interview).

As part of their multidisciplinary scope the AWG also found space within their membership for individuals whose capacity to meaningfully contribute to a stratigraphic assessment of the Anthropocene was far less clear. For example, Davor Vidas - a lawyer - who joined the group to help make sense of the implications of the Anthropocene for maritime law (Vidas 2011; Vidas et al 2015). Despite his non-expertise in stratigraphy, Vidas was credited with co-authorship of a number of more technically and stratigraphically oriented publications by the AWG, including arguments for the stratigraphic reality of the Anthropocene (Waters et al 2016; Williams et al 2016), highly technical discussions about the setting of the lower boundary (Zalasiewicz et al 2015a; Zalasiewicz et al 2015b), alongside responses to on-going criticisms about the non-stratigraphic nature of the AWG’s activities (Zalasiewicz et al 2012a; Zalasiewicz et al 2017). Nonetheless, the leadership of the AWG were willing to defend Vidas’ role in the AWG. He might have been a “maverick choice”, but he was a choice that “turned out exceedingly well” (1x interview). Vidas may not have been “a scientist, but... he was using the science of the Anthropocene [properly],” and was “very quick in assimilating” the science in spite of his lack of formal qualification (ibid).⁵⁰ Similarly, the inclusion of Andrew Revkin - an environmental journalist - was internalised and normalised by the role that he served as a “guide into [the] wider world” (ibid). He might be “on the fringes of stratigraphy” but he provided an “ear to the ground” that allowed the group to

⁵⁰ Beneficially, Vidas also possessed the kinds of contacts and connections that could help the group access the particular sections and cores that would form the basis for a later formal proposal (1x interview).

consider the implications and consequences of their work for communities that were not otherwise represented within the group. So long as the group's remit retained some sense of the 'utility' of the Anthropocene for a broader community of earth and environmental scientists alongside an investigation of the stratigraphic merit of the Anthropocene itself, then Revkin and Vidas became necessary resources for the AWG (ibid).

Buoyed with a surfeit of members and often-conflicting perspectives, the AWG was remarkably prolific in channelling their efforts into the production of a large and detailed body of work that - while sometimes contradictory - largely advocated for formalisation of the Anthropocene. Two special editions, published in 2011 and 2014 (Zalasiewicz et al 2011a and Waters et al 2014a respectively), exemplified these efforts. The first of these special editions was published in *Philosophical Transactions of the Royal Society* and consisted of 13 articles. Those articles considered geology and maritime law (Vidas 2011), societal responses to the Anthropocene (Tickell 2011), and an exploration of the coupled dynamics of climate and the economy (Kellie-Smith et al 2011). This first special edition also featured macro level arguments about deep time analogues for contemporary global warming (Haywood et al 2011) and discussions of extremely local phenomena like lead signatures in the Clyde estuary in Glasgow (Vane et al 2011). The AWG's second special edition was published by the Geological Society of London and consisted of 18 articles. These articles considered how the geological materials of the Anthropocene might be recognised (Zalasiewicz, Williams & Waters 2014), discussed the mineral signature of the Anthropocene (Zalasiewicz et al 2014a), and examined the palaeontological evidence for defining the Anthropocene (Barnosky 2014). Further articles considered the geomagnetic and mineral magnetic character of the Anthropocene (Snowball et al 2014), the use of geochemical methods in stratigraphic assessment (Gałuszka et al 2014), the use of volcanic markers in the identification of a putative lower boundary (Smith 2014), the overlap between Anthropocene stratigraphy and archaeology (Edgeworth 2014; Williams et al 2014), and the relationship between geology and technology (Haff 2014a). Beyond these special editions the AWG and its members produced articles in *Nature Geoscience* (Zalasiewicz 2013), in *Quaternary*

International (Zalasiewicz et al 2015a), in *GSA Today* (Zalasiewicz et al 2012a), and in *Rendiconti Lincei* (Zalasiewicz & Williams 2014) amongst a range of other journals. After their foundation, the AWG also made a point to publish in the dedicated Anthropocene journals *Anthropocene* (Zalasiewicz et al 2014b; 2016) and *The Anthropocene Review* (Zalasiewicz et al 2015b). The evidential case that the AWG built across these articles culminated in a landmark publication in the journal *Science* in early 2016 (as Waters et al 2016) in which the group synthesised their stratigraphic arguments and outlined their belief in the specifically stratigraphic reality of the Anthropocene.

Tensions at play in this body of work led to the resignation of one high-profile member who felt that their stratigraphic concerns about the group's thinking were being disregarded by the group as a whole (1x email).⁵¹ Between 2014 and 2016 the AWG's efforts also faced sustained criticism from the then Executive Chair of the ICS Stan Finney (Finney 2014, Finney in Carey 2016) and a co-author in the US Geological Survey (Finney & Edwards 2016) and elsewhere from the SQS' Holocene Working Group (Gibbard & Walker 2014) for an accused failure to conform to, or even understand, the stratigraphic process of investigation. In particular, in his 2014 critique Finney suggested that the Anthropocene was more akin to an historic term than a stratigraphic one and argued that 'the Anthropocene' seemed irreducibly vague when more specific terms were available. Questioning the role for a stratigraphic investigation, Finney noted that the material bodies that result from human activities were more accurately identified by using archaeological terms like 'Babylonian' or 'Roman' that describe the civilizations that produced them (p25). Due to the significant "lag between a human-induced perturbation... and it becoming permanently recorded in a stratigraphic succession," Finney also questioned whether the Anthropocene was less a stratigraphic argument than a projection into the future (ibid). Finney and Edwards' 2016 criticism focused further on the accusation that the AWG had failed to consider their investigation in terms of formal stratigraphy. Noting the limited interest paid to the formal

⁵¹ This was chased by the later resignation of another member in August 2016 over concerns that the group was moving away from their original area of interest, and that they "didn't necessarily agree with all the decisions [the group] were making" (1x interview).

strictures of the International Chronostratigraphic Chart or the role of the ICS in the group's efforts to explore the Anthropocene (p4), Finney and Edwards reinforced the role of a set of particular institutional mechanics in the form of a formal written proposal detailing "candidate stratotype sections and boundary levels worldwide" in the production of a proper stratigraphic case (p6). In doing so, Finney and Edwards sought to problematise the role of non-specialist actors in shaping the AWG's output. Targeting the notion that the Anthropocene be drawn from observational records more so than the stratigraphic record, Finney and Edwards countered the AWG's broad enthusiasm for the Anthropocene by reminding the group of the long existence of the discipline prior to the Anthropocene question (Finney & Edwards 2016, p6). In effect, they raised challenging questions about what methods were acceptable for the discipline and their validity for the epistemic practice of stratigraphy.

These critics might recognise a discipline whose history is built upon the critical contingency of early geological work that was subject to its own internal politics, competition over influence, and struggles for authority (see Rudwick 1985; Oldroyd 2003), but they saw a duty to protect a discipline that could offer rough but useful delineations between the intervals of geological time as a result of its reliance on the slow sedimentary processes of marine rock (1x interview). Critically, they saw a system that had largely stabilised and hypostatized around its contemporary set of globalised divisions by the 1990s (1x interview; see also Miall 2016, pp 3-17) by consequence of the work of geological surveys - "government bodies that are hardly open to change" - acting in the interests of petroleum and mineral geoscience to identify stratigraphic sequences above and below the surface and across the globe (1x interview; see also Miall 2016, p2). As one member noted, this system was pragmatic in its accommodation of new techniques and methodologies over time, for example radiocarbon dating and the discovery of a Precambrian that predates the complex fossil assemblages on which the discipline had previously been dependent (1x interview; see Miall 2016, p94). Other experienced stratigraphers in the AWG offered a slightly different reading, noting the relative inflexibility caused by an institutionalised desire to maintain consistency so that a researcher might pick up a textbook 50 years hence and "still be able to recognise the

units” (2x interviews). Members might all agree that change is driven by collective decisions about what to call legitimate knowledge, but there remained a challenge over the speed at which that change was meant to occur. Critics felt justified in pointing out the potentially large consequences of the Anthropocene and the need to carefully manage and integrate any impacts this would have on the discipline through a “gradualist approach” that would minimise harm and disruption (1x interview). For advocates of change within the AWG the need for a pragmatic approach that could account for new kinds of data was driven by the “practical need to find the most effective boundary” for any given period of change as had already been recognised with the formalisation of the Holocene (1x interview). Thus they could make sense of their own incorporation of external expertise to a slower process of “evolution” (ibid) rather than the more drastic process of rewriting the rules implied by Finney.

The AWG’s most substantial effort to reconcile the more-than-stratigraphic elements of their investigation was an article published in American Geophysical Union journal *Earth’s Future* in July of 2016 (as Steffen et al 2016) co-authored by the entirety of the AWG’s membership - with the notable exception of Philip Gibbard - and earth system scientists Hans Joachim Schellnhuber. The AWG’s stated aim with the article was to reconcile, or “integrate”, the ESS and stratigraphic perspectives on the Anthropocene (p324). Nonetheless, this article doubled down on a number of points of difference between the ESS conception of the Anthropocene and one that might be acceptable to stratigraphic gatekeepers like Finney. Firstly, the integrated vision of the Anthropocene presented therein was oriented around possible future trajectories for Anthropocene development. In defiance of Finney’s earlier criticism, the AWG’s own recognition of the lag between anthropogenic impacts and their impact on geological deposits (Waters et al 2015, p55), and the recognition by contributors of the ongoing challenges of reconciling stratigraphic evidence that was “already in the rocks” with an earth system science perspective (1x interview), the Anthropocene was still an act of modelling and speculating about possible future outcomes rather than a description of existing sedimentological evidence. Instead of existing strata, the vision of the Anthropocene presented in this article was defined in terms of a conceptual ‘ball-and-cup model’ by

which the earth system was said to occupy a 'basin of attraction' to which the system state ought to return absent further (anthropogenic) pressure. As Figure 6 demonstrates, here the Anthropocene was imagined not as "a stable state but... [as] a trajectory away from the Holocene" with an outcome both indeterminable at this current point in time, and subject to on-going human decision-making (p337). While the article did draw comparisons to more explicitly stratigraphic arguments produced by the AWG, this vision of an ESS Anthropocene maintained a sense of ambiguity about its 'epochal' hierarchical status. The "outcome is not yet clear" (ibid) and "cannot be predicted with any confidence" because of its entanglement with on-going human decision making processes (p338). Instead, this argument suggested a new conceptualisation for a new type of geological interval: future oriented, and indeterminate in length. In response, the group sought to identify the onset of a new interval of time rather than the end of a previous interval.

Critically, this paper argued that ESS and stratigraphy would both gain from integration, without ever clarifying what it was that stratigraphy might benefit from this new arrangement. Instead, the paper's position hinged on the notion that stratigraphic interpretation of earth history had been replaced with the development of a new and improved integrative discipline and the potential that this new discipline held for both interpreting earth history and projecting earth history into the future. ESS might have "benefited from evidence generated by... stratigraphy" and stratigraphy's role in the development of the International Chronostratigraphic Chart (p325), but it was the integrative and holistic nature of ESS and its vast ambitions towards the synthesis of data that even allowed for the proposal of an Anthropocene (p333; also Robin & Steffen 2007). In this way, the group presented a vision of the relationship between ESS and stratigraphy by which stratigraphy had generated knowledge of earth history by uncovering periods of change, but thereafter it had fallen upon ESS to interpret that change in terms of a "complex-systems framework" that could feed back into the stratigraphic understanding of the planet and produce new stratigraphic insights and challenge existing stratigraphic interpretation (ibid). Explicit in this argument was a sense of a new type of work - ESS - becoming a vital part of an older field. Conceding

Finney's criticism the AWG actually stated "for the first time, a major shift in the state of the earth system was proposed on the basis of direct observation... without specific reference to evidence in the stratigraphic record" (ibid). In so doing, they argued that we had entered a period in which "real-time stratigraphy" drawn from ESS observation and theoretical modelling of future strata might be considered the norm.

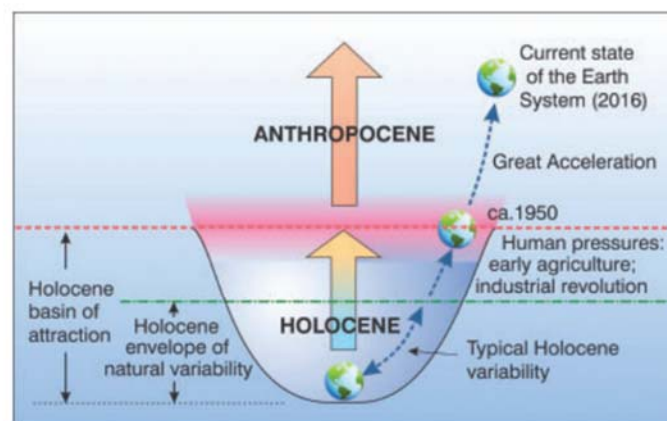


Figure 4. A ball-and-cup depiction of the Earth System definition of the Anthropocene, showing the Holocene envelope of natural variability and basin of attraction. The basin of attraction is more difficult to define than the envelope of variability and so its position is represented here with a higher degree of uncertainty.

Figure 6: Anthropocene as a 'ball-and-cup' model. Diagram from Steffen et al (2016) 'Stratigraphic and Earth System approaches to defining the Anthropocene' (p336).

Thus the group sought to enrol the language of stratigraphy - as well as features like GSSPs and GSSAs - where they might have utility for ESS moving forwards. In this way, the boundaries that GSSPs and GSSAs represent were said to "help constrain the pattern in time and space of changes in the behaviour of the earth system" even as ESS' focus on complex modelling rendered abrupt boundaries less beneficial and ultimately less meaningful (p327). As the group argued, greater access to granular data - particularly as concerns geologically recent transitions like the putative Holocene-Anthropocene boundary - would mean that the diachroneity of boundaries become ever more apparent in practice. Thus, in the argument presented here existing stratigraphic boundaries would maintain their value only insofar as they represented changes in the earth system state, or where they correlated to an earth system change even without

representing the nature of the transition itself (ibid). In this way, the AWG implied a hierarchical ordering between these two disciplines by which stratigraphy would serve to illustrate that change had indeed taken place, but it would fall to ESS to provide a meaningful analysis of the cause and consequences of that change. In the view that the AWG presented here the empirical observation that was provided by stratigraphy would need to be supplemented with the additional theoretical insight into system change that only ESS could provide, leaving stratigraphy somehow secondary to the real insight provided by ESS (p328). To support this ordering, the group devoted four pages to “unraveling earth system evolution from the Chronostratigraphic Record” (pp 329-333). That is, interpolating the ‘empirics’ of the International Chronostratigraphic Chart - as discerned through the practice of stratigraphy - with the theoretical insight that ESS alone could provide (1x interview).

6.3. Political Advocacy and the ‘Mission’ of the AWG

The second major contribution of the AWG’s effort to reconcile ESS and stratigraphy was the reintroduction of an explicitly political position, with the AWG here making multiple references to the normative dimensions of global change and the international target of limiting mean global surface temperature to less than 2°C above pre-industrial levels as agreed at COP-21 (Steffen et al 2016, p339). Despite having dropped an explicitly political orientation when they embraced their stratigraphic remit, the group once more framed their discussion around the need for humans to enact “a rapid shift... toward the UN Sustainable Development Goals” in order to “stabilize the earth system” at an approximation of its current state” (p324). As a result, the decision to draw in external expertise on the Anthropocene does appear to have had implications for the AWG’s collective sense of purpose. To be sure, some members made sense of the AWG in terms of a wholly neutral assessment or investigation of the sediment record that neither favoured formalisation nor attached emotional significance to the work (1x interview). For these members the role of the AWG was variously a question of “whether or not it is desirable to attempt stratigraphic formalisation of the Anthropocene as a new interval within the geologic time scale” (1x survey), the production of a

“recommendation on the feasibility of establishing a new epoch of geological time” (1x survey; similarly expressed 1 further survey), an assessment that either “supports or refutes the hypothesis that the Holocene has ended” (1x survey), or a determination of “whether distinctive, lasting geologic criteria exist to demarcate recent deposits from typical Holocene and older deposits” (1x survey). They were, emphatically, “not trying to act as a pressure group” for formalisation (1x interview). These members - generally well established stratigraphic specialists and well advanced in their careers - stressed a neutral scientific language of exploration, assessment, and the pursuit of “true... knowledge” (1x survey) in service of the AWG’s formal stratigraphic remit.

Those members of the AWG with the greatest familiarity with the institutional strictures of stratigraphy also appeared to be aware of a ‘hard boundary’ on their efforts in this regard. That is, they knew that it was not within their remit to discuss the Anthropocene in terms of advocacy, and that if they were to stray too far into political discussions their association to the ICS would be revoked and they would be asked to cease their activities (1x survey). For these members the job of the AWG was simply to “interpret the facts” and produce “nothing more than a definition” (1x interview) without a care for how other groups might make use of the term (1x survey). Such members were keen to clarify that the group was “universally agreed” that their ambition was not political in “the narrower sense” of that word (1x survey). Those stratigraphers in the group who held additional roles within the SQS felt particularly reluctant to get involved in what they called the “green issue” (2x interviews). Instead, they saw it as their personal role within the AWG to preserve the institutional interests of the ICS and to carefully safeguard the conversation from drifting into such openly political discussion. This included ensuring that the group did not use the Anthropocene as a means to provide “spurious official acceptance” of the reality of anthropogenic global change or to “convince non-believers” (ibid).

For these members, the Anthropocene was not “about being pro~ or anti~ the green lobby, the whole question of greenhouse warming, climate change, or human driven climate change as a political activity” but rather more simply about addressing the

Anthropocene hypothesis from the perspective of a geological understanding of the natural environment (1x interview). Following this lead, some members of the AWG were clear in the language they use to describe their “charge” (1x survey) or “specific remit” (1x interview). As far as the group were willing to express the potential implications or consequences of their work, it would only mean that “geologists [would] be required to start referring to the time period correctly” (1x survey). There might have been a broader Anthropocene conversation in play, but members tended to view that broader conversation as an outside or “alien” discourse over which they had limited responsibility or jurisdiction (1x interview). In this way members sought to minimise their responsibility to speak for and corral the use of the Anthropocene only amongst ‘scientists’ - loosely defined - because this was a community familiar enough with the rigorous application of concepts (ibid) to use the Anthropocene that the AWG defined in a “proper” way (1x survey). Nonetheless, the boundary between what was scientific fact and what was - at least partially political - was not always clear. One member noted that the AWG was not in the “game of predicting the future” because their role was simply to detect what “has already happened” and was “already recorded in the geological record” (1x survey). As a member of the AWG, they “forecast the future no more than an Ordovician stratigrapher would” when looking at rocks from 450 million years ago (ibid). But even as this member asserted that the group were not “seers of the challenges that lie ahead,” they noted their ability to foresee “successes for humankind’s collective futures” (ibid).

By contrast, those members with less familiarity with the (practiced) political neutrality of stratigraphy appeared more willing to define the AWG’s remit in terms of actively supporting the case for formalisation. In doing so these members suggested that role of the AWG was to assess and communicate to the ICS how to “best proceed” with the process of formalisation (1x survey). In this sense the group’s role was about stratigraphy further ‘authorising’ (see Shapin 2010, p26; p311) the Anthropocene and grounding it in an empirical practice and granting their vision of the concept greater weight. For these members stratigraphic formalisation served to confirm the “natural science basis of the Anthropocene” (1x survey), taking observational and modelling

data and confirming its “reality” with the “long-lived and unmistakable evidence” of the sedimentary record (1x interview). Stratigraphic formalisation simply served to make the Anthropocene “real” (1x survey), consolidate contemporary global change in the “factual record” (1x survey), and convey “the magnitude of human-driven changes” in a way that “mostly gets around the highly politicised debates around climate change” (1x survey). Less familiar with the institutional processes of stratigraphers, one geomorphologist on the group offered a slightly glib dismissal of debates over appropriate criteria like GSSAs and GSSPs, by suggesting that the group use such language for the benefit of the geological community. In this way the group might better ‘convince’ that community - through the deployment of their own standards - of the reality of the Anthropocene with which the group was already highly familiar (1x survey). Even after joining the AWG Crutzen described the Anthropocene in expressly political language (Crutzen & Schwägerl 2011; Crutzen in Schwägerl 2014), and Will Steffen wrote alongside Jan Zalasiewicz on the implications of the Anthropocene for ‘planetary stewardship’ (Steffen et al 2011b). Elsewhere, Steffen also published alongside Johan Rockström in the explicitly political ‘Planetary Boundaries’ literature (Rockström, Steffen & Noone 2009; Rockström et al 2009b). As one member made clear there were lines to be drawn around the politics of these efforts with reference to the institutional structures that hosted them. Thus the Anthropocene might sit “strongly on the natural science side of that very fuzzy and very important boundary between natural science and policy, politics, social science, humanities, normative and subjective views on this” but it was only with the term ‘Planetary Boundaries’ that “the normative dimensions come in” (1x interview).

Even those who professed the political neutrality of the AWG’s efforts seemed to at least recognise the communicative potential of stratigraphic formalisation. Others supposed they could police the boundary between their science and something more political through a language of their being a “technical and objective working group” (1x survey), notions of scientific professionalism and a “technical... charge” (1x survey), and through a boundary drawn between members’ public and private, group and individual personas (1x survey). Nonetheless, one member spoke about formalisation in terms of

“filtering out... the noise [to provide] a simpler signal” (1x survey), an act that implied a desire to produce a transferable message that the group, or others, might apply in non-stratigraphic contexts. Despite clearly expressing the political neutrality of the SQS, some members recognised the symbolic role of formalisation in “emphasis[ing] the trajectory of our planet, and caus[ing] policymakers to focus on its causes” (2x interviews). One non-specialist believed that the term would “inevitably” add to other concepts in contemporary environmental sciences that “both [reflect] and [create] greater consciousness about the heavy human impact on the natural environment” (1x survey), and, mirroring Crutzen, another non-stratigrapher in the group suggested that like scientific evidence for the hole in the ozone layer, the Anthropocene would provide “a framework for understanding the human capacity to both damage and repair earth systems” (1x survey). Other members “very much [hoped] for formalisation” because it would “demonstrate the profound impact of humans” and “help to formulate ideas about good human stewardship of the biosphere” (1x survey; 1x interview). As one member noted, there was “great utility” to formalisation as a “mechanism to help identify the degree to which we have changed our environment and the way that we interact with it” (1x interview). In this way, members could envisage the authority that stratigraphic formalisation would leverage in political conversation in an area - climate science - that had been subject to much political gerrymandering and “[reluctance] to publicly admit how much our environment has changed because of our actions” (ibid).

Whether the primary motivation or not, formal ratification would place “an exclamation point on the recognition that [humans] are a force of nature” and would “underscore the intensity with which humans are altering the planet” (1x survey).

I think it will be one way of one scientific body saying, look, this is huge, this is significant, this is like the Cretaceous-Paleogene boundary, we have to respond to this as a species, and therefore it might be just another way of galvanising a greater response from our politicians and those in positions of power, who can actually help to very strongly influence the debate, about the human impact, and how we become stewards and not

dominators, I think, of the earth's system. We're really going to seriously damage those life support systems that our children and grandchildren will need for the future.

(1x interview)

For members then, the changes that the Anthropocene was said to represent and the “direct connection these have to our wellbeing” (1x interview) meant that they could not ignore this communicative potential. Their epistemic burden was not limited to proving the ability of stratigraphy to answer the Anthropocene question, but a broader burden of proof to the public. Failure in the form of non-ratification would “be bad for environmental decision makers” because of the inappropriate message it could send even if it were done so for sound stratigraphic reasons (1x survey).⁵² Opening a space between scientific reality and scientific status, one member pointed to their own decision to talk of the Anthropocene as an epoch only - despite believing that many changes were in fact greater than epochal - because “any higher rank would be very unlikely to be approved” and thus rob the Anthropocene of the rhetorical power it might achieve through formalisation (1x interview). For earth system scientists in the group the question of unknown trajectories meant that the epochal designation of the Anthropocene would always be to some extent open-ended more so than settled (1x interview). Nonetheless, that there was a normative dimension at play in their thinking was simply a sign of the importance of the Anthropocene. As one stratigrapher in the group noted, “if something's political it probably means it's important” (1x interview). Following this logic the stratigraphers in the group could rationalise these more normative aspirations even as they sought to downplay their significance or the influence they might have on their decision-making process. As one stratigrapher in the group noted, “if it adds to a diversity of thought within the Anthropocene Working Group, then that's fine” because the proposal the group would ultimately produce would rest on scientific and not political arguments (1x interview).

⁵² Another member - keen to stress that making a statement was “not the goal of the AWG” - nonetheless noted that formalisation might “help politicians and decision-makers to consider that we have the ability to ensure that [some] of the signals [for the Anthropocene] represent transitory blips in the geological record and that we don't progress to ever more pronounced signals” (1x survey).

Steven Yearley notes how sceptics of science persistently argue that the cultural authority of science is maintained in part by scientists exaggerating claims in order to maintain funding and epistemic authority (see Yearley 2005, p162; also McCright & Dunlap 2000). Yet this is exactly what was at stake for some advocates for the Anthropocene within the AWG. Where their arguments for formalisation also incorporated aspects of how others downstream of the decision might react to formalisation, members implied that it was the very authority that the traditions (see Collins 2013) of stratigraphy could bring to this new epistemic thing - tentative and as yet underdetermined - that gave it the necessary stability to be transferred into political action. Rather than expand from a purely scientific framing to account for this kind of political intent, members instead sought to rely on the specifically scientific authority of stratigraphy to press his normative vision. The danger here lay in the implication that a clearly political discourse that might otherwise be regulated by religious, moral, and legal language could instead be conducted through a novel technical vocabulary. This kind of 'anti-democratic' sentiment (see Ezrahi 2004; Swyngedouw 2010) meant that instead of discussion and deliberation, the Anthropocene and its implications would be subject only to particular forms of expertise. The aim was laudable, intended as it was to target what Karen O'Brien has called the disjunction between science and the social response to scientific findings (2012), the very same thing the Stratigraphy Commission had highlighted in their earliest efforts in *Science in Parliament* (Zalasiewicz et al 2006). But, by on-boarding this future oriented vision of the Anthropocene members of the AWG had opened themselves to the accusation that they had decided to use the Anthropocene to 'shout louder', plying the authority of their science in the hope that it could do some good in the world in an attempt to overcome the distorting effects of public distrust (see Yearley 2005, p122; also Owens 2000, p1142).

During interview one member pointed to an internal group vote in August 2016 to express bafflement that the number who had voted in favour of formalisation appeared to have little relation to the character of the conversations the group had been having by email (1x interview). As a result this member felt confused that some within the group

had traded away their honest opinions on Anthropocene formalisation for political reasons. This member stated that they were originally sympathetic to doing the same thing “as a pragmatic measure” thinking that the Anthropocene would not be formalised in any case, and recognising the need to find something “the biggest hammer...” “to pound the shoe on the table with” (ibid). However, this member nonetheless believed that because even those who disagreed profoundly with the Anthropocene at least came to take it seriously, that work “[had] been achieved. Mission accomplished” (ibid). The AWG had been successful insofar as it had succeeded in validating the concept, and demonstrating its on-going value as an epistemic thing worthy of investigation. To lock down that accomplishment with a “line in the sand,” however, would only create further problems, excluding the very voices that the AWG should recruit if they wished for their concept to have meaningful political dimensions. This member’s confusion with and criticism of his colleague’s decision to favour consensus over the ‘truth’ of the matter - a more complex history of slow and continuous change that had simply accelerated in the recent past - implies that the group recognised that a political world is at stake in their decision.

However, if the group was guided - at least partially - by a sense of political mission, then this was not apparent in their output. Instead, the group took the complex, contested, and negotiated dynamics of their investigation and presented them through the ‘far simpler’ language (see Powell 2007; Latour 1987) of stratigraphy alone. This rhetorical strategy resulted in something ‘gained’ and something ‘lost’ (Latour 1999, p70), namely, a familiar language at the cost of clarity about the group’s thinking, which was instead ‘negotiated out’ of the presentation of their efforts (see Pinch 1985). In fact, it could be argued that the group actually gained from portraying the Anthropocene as a simple stratigraphic division, even as this obscured their broader political thinking. For example, given the historic importance of palaeontological (fossil) records in the division of geological time (as acknowledged by Zalasiewicz & Williams 2014, p10; and Barnosky 2014, p161), the AWG strained to produce arguments that similarly made use of the fossil record. These efforts resulted in the development of the concept of the ‘technofossil’ across a number of papers (Zalasiewicz, Waters & Williams 2014;

Zalasiewicz et al 2014b; Williams et al 2016), a new category of fossils that would allow the AWG to translate human technologies - novel and unprecedented in geological time - into the accepted language of the palaeontological record. The language of technofossils and technostratigraphy - the new subdiscipline that would deal with technofossils - were designed to resemble their familiars in biological material and biostratigraphy, with changes in technofossil assemblages to be described in terms of their “rates of evolution” (Zalasiewicz et al 2014b, p37).

As a result of this language other stratigraphers outwith the group might better understand the stratigraphic connections that the group were attempting to draw, but the AWG’s own motivations and thinking, and their more-than-stratigraphic understanding of the Anthropocene were obscured. A particularly interesting example lies in the group’s attempt to present the technofossil record in the language of ‘ichnology’, the study of the traces of organismal behaviour. Here the group noted that the “range and diversity of technofossils means that one could indulge in fine taxonomic ‘splitting’ and hierarchical categorisation of the artefacts in terms of morphology and function” (2014b, p40). Developing this ichnological argument, the AWG posited that a toothbrush was no longer a toothbrush, but rather “one type of artefact” within the broader “category of brushes and brooms” (ibid). Collectively, they argued, these are all “cleaning traces” (ibid). Thousands of different variations of brushes may have been produced using different materials and manufactured in different places, but this simply rivalled the same kind of diversity one might find when dealing with biological specimens (ibid). This translation of known and historical processes into stratigraphic nomenclature was argued to complement existing “archaeological, historical, and everyday vernaculars”, but would mean something like a food processor would need to be reclassified as a ‘pascichnia’, a trace fossil related to feeding processes (ibid). Elsewhere similar neologisms like ‘anthroturbation’ served to connect the existing language of ‘bioturbation’ with the particulars of human impacts (Ford et al 2014, p83), and megacities were described in terms of their resemblance to complex “burrow systems” and - in Figure 7 - their ‘evolution’ was discussed as if they were multicellular organisms (Williams et al 2014, p146). While such language might have helped the

AWG to draw connections between current anthropogenic change and past geological change, it raised questions about the intended audience for that knowledge. A future geologist may have to piece together cleaning traces to make sense of ancient behaviour, but scholars acting on that knowledge today have no such need. Taken alongside the more interventionist perspective nascent in the group's thinking, these efforts imply that the AWG were torn between a desire to produce an Anthropocene stratigraphy that was completely consistent with their understanding of past divisions in the International Chronostratigraphic Chart, and at the same time produce a politically moveable stratigraphic thing of a type that stratigraphy had not previously been required to do.⁵³

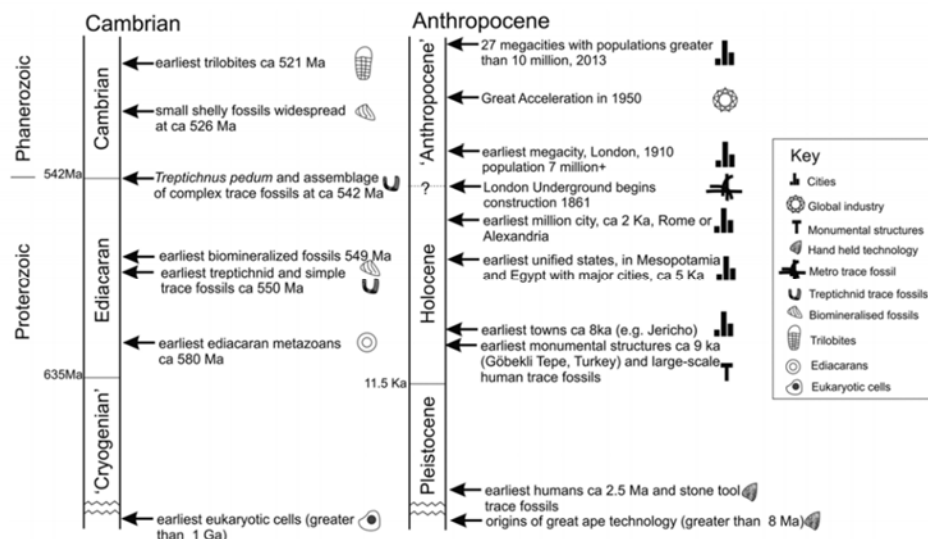


Figure 7: A visual analogue between the evolution of complex life forms and human cities from Williams et al (2014, p145).

Despite the role that a political imaginary played in informing the views of the AWG, only two members received criticism for the specifics of the positions they voiced. Both were

⁵³ It would be a distortion of historical reality to claim that amendments to the stratigraphic column have not previously carried broader cultural implications. For example, 19th Century geologists found themselves in conflict with theologians over the age of the earth (see Gregory 2003, p323), and their 20th Century colleagues found themselves engaged in questions over the accusation of an implicit Eurocentrism to the theory of continental drift (Rupke 1996). The point is simply that the AWG's efforts pushed against an accepted and practiced cultural norm within the discipline in its modern form.

proponents of what is called the ‘good’ Anthropocene, an argument that suggested that now we know that humans have become a geophysical force, ‘we’ must act on that knowledge and make the most of this new epoch. This argument was most commonly associated with a document called *The EcoModernist Manifesto* (Asafu-Adjaye et al 2015), on which AWG member Erle Ellis was a co-signator. The ecomodernist argument held that economic growth was already decoupling from increased per-capita emissions, so the best way to manage global environmental risks was simply to allow technologies to develop further and become ever more efficient. In effect, if left to its own devices, the market would bring emissions and resource-use down without the controlling hand of specifically environmentalist guidance. For proponents of the ‘good Anthropocene’ this reframing simply acknowledged the impossibility of not having an openly political conversation about the Anthropocene. As another advocate - Laura Pereira - has stated,

if we understand the Anthropocene as an era in which humans are a dominant force on the planet – for good or for ill – then returning to a previous age (i.e. the Holocene, when humans were NOT the dominant force) is not a likely option; we cannot turn back the clock, but must therefore proceed into the ‘future-as-Anthropocene’”. The impetus becomes a question of the least worst [sic] option, “a ‘good Anthropocene’ rather than a ‘bad Anthropocene’.

(Pereira 2015, online)

Thus, proponents of the ‘good Anthropocene’ argument believed that it was important to recognise the Anthropocene as both a specific fact and a kind of political tool. As such the duty of scientists was to frame the Anthropocene appropriately, such that it would encourage the public and politicians not to give up on the possibility of change, and to prevent a hopelessly catastrophist framing from inhibiting any action. While AWG member Andrew Revkin did not help in drafting *The EcoModernist Manifesto*, he was also repeatedly criticised for professing optimism about the Anthropocene in his own

personal and journalistic writing (Hamilton 2015b; 2014a; 2014b; 2014c; see also Revkin 2014a).

Critics of the 'good Anthropocene' denounced the notion as a "delusional fantasy" by which conservatives attempted "to defend the status quo against the evidence that the [cause of the Anthropocene was] techno-industrialism's aggressive fossil fuel-driven capitalism" (Hamilton 2014b; 2014a; Hamilton in Johnson 2014; Angus 2017; Romm 2014). But while Ellis was singled out for supposedly bending science in favour of a conservative political agenda, his critics often spared his co-authors from the same critique. Ian Angus, for example, suggested that Ellis' co-authors did not "realise that [the articles they co-authored with him were] part of a political campaign against Anthropocene science" (Angus 2017). Likewise, Clive Hamilton was forced to acknowledge an earlier co-author of Ellis, eminent palaeoclimatologist William Ruddiman, as someone who could not be 'tarred with the same brush' as Ellis (2014b). Another of Ellis' critics, climate expert and communicator Joe Romm, elsewhere cited climatologist James Hansen approvingly for "deftly dismissing" advocates of the 'Good Anthropocene' with his own warnings about the incoming "Hyper-Anthropocene" (2015; see also Hansen et al 2016). While Romm felt comfortable attacking Ellis (and Revkin) for assigning an inappropriate political agenda to the Anthropocene, he expressed adoration for Hansen in doing the same thing both here and during his famous testimony to the US Senate in 1988 - pre-empting peer review in order to take a political stance on scientific findings (see Kerr 1989) - for different, 'better', reasons. Despite the heightened attention that he received, it seems clear that Ellis was not some parasitical agent politicising the Anthropocene discourse with little regard for the science. Ellis' politics may well have differed from the more obviously environmentalist position of a number of other members in the group, but the challenge was true for all members: all were required to negotiate the complicated boundaries of their investigation, but the group's output focussed on the scientific dimensions of the Anthropocene without making space to explore its political implications.

6.4. Conclusion

It would be overly reductive and unfair to suggest that the only outcome of stratigraphic formalisation would be to lend greater legitimacy to the AWG's more-than-stratigraphic sense of the Anthropocene. In either case - whether by intention or by accident - formalisation of the Anthropocene in terms of the broader ESS influenced vision that the AWG had adopted by 2016 would have consequences for the epistemic practice of stratigraphy. Thus we can see that the AWG's response to the epistemic burden of the Anthropocene was not only a question of bundling together various domains of expertise but also a bigger and more challenging question about the discipline's role in the broader discourse to which it now responded. Because the AWG had imported ESS with all of its explicit references to management, trajectories, political governance, and the future - alongside a range of other perspectives - they appeared to have moved beyond the purely 'objective' description of the earth that they recognised as their formal remit. Beyond the cultural norm seemingly held by a number of prominent voices in the discipline there was no reason why such features cannot or should not be part of an Anthropocene stratigraphy. Indeed, the AWG was not alone in expounding the fundamentally 'better' understanding of the earth system enabled by ESS (see Hamilton 2014b; 2016a; Lewis & Maslin 2015a; 2015c). What remained a challenge however was the way in which the AWG had come to embrace these values and allow them to inhabit their conception of the Anthropocene without making them explicit, transparent, and subject to open and on-going discussion and scrutiny in the body of work they produce to support stratigraphic formalisation (Pinch 1985; Ezrahi 2004; Powell 2007). Instead, the group risked presenting a picture of the Anthropocene that could be completely stratigraphic, even as they developed a more ambitious version of that concept that would be unrecognisable to the body that could ultimately grant formalisation. In that sense the group sought the benefits of multidisciplinary investigation and presented a neat vision of a new 'integrative-synthesis' of disciplines (Barry, Born & Weszkalnys 2008), while trying to hold onto the cultural authority provided by the particular disciplinary status of stratigraphy (Collins 2013). More problematically, there were those within the group that sought to leverage the political neutrality of stratigraphy - and

scientific objectivity more broadly (Yearley 2005) - to give this epistemic thing greater power in the belief that it might influence political dialogue.

Chapter 7: Invisibility and Opportunism in the Spread of the Anthropocene

7.1. Introduction

In the previous chapters I traced the onset of the Anthropocene controversy and the response to the concept's emergence by the Anthropocene Working Group. As I have argued, the dimensions of the Anthropocene concept meant that the group struggled to contain their investigation to stratigraphy alone. While I explored the stratigraphic response to the 'multidisciplinarity' of the AWG's efforts in the previous chapter, the AWG's prolific output also drew a wide-ranging response from outwith the discipline. In this chapter I trace this response and its role in expanding the parameters of the Anthropocene controversy. As before, this broader interest raised questions about the appropriate authority and expertise to speak to and for human-environment relations. Accordingly, interlocutors variously proffered a series of alternate start dates to the Anthropocene and a series of alternative names for the new geological epoch that the Anthropocene was said to represent. Beyond a simple matter of different dates and different words, interlocutors sought to shift the discourse around the Anthropocene by bringing new dimensions into view and giving them greater status in debate. Making explicit the implicit politics of the AWG's own efforts, many of the interlocutors that I discuss below demonstrated an understanding of the role that the Anthropocene could play as a narrative device to frame socio-political discourse. Critical engagements in the social sciences and the humanities - in particular - seemed suspicious of the role that the Anthropocene might play in legitimising and promoting a narrative of governance and control. As well as revealing the different epistemic groups and different epistemic parameters of the Anthropocene controversy, these interventions also demonstrate how different groups saw the dating and naming of the Anthropocene as openings they might 'opportunistically' rearrange (Pickering 1984, p10) in response to what they perceived to be a hegemonic discourse emanating from the AWG. As a result, their desire to trade off the authority of stratigraphy was based on value-driven decisions about the kinds of work that the concept and terminology 'Anthropocene' might allow them to do. Without condemning this mode of engaging with the Anthropocene concept

I note how these interlocutors also generated further interest in the Anthropocene controversy as a result of their engagement, creating a feedback cycle by which the Anthropocene grew as a discursive space and began to unmoor from its particular disciplinary associations with stratigraphy.

7.2. Other Anthropocenes and Other Stories

By pulling together the efforts of a range of interlocutors in the earth and environmental sciences it is possible to construct a series of Anthropocene lower boundaries that stretch from before the onset of the Holocene through to the more recent past. These alternatives can be loosely parsed into two camps. The first consisted primarily of 'early Anthropocene options' that paid less attention to the importance of the single isochronous boundary - so important to the process of stratigraphic formalisation - and instead sought to locate the causes of change that then amplified over time. By contrast, the second consisted of more technical arguments that advocated a specific but alternative lower boundary date for the Anthropocene in the form of a new prospective GSSP (see Figure 8). Amongst those early Anthropocene options, ecologists Christopher Doughty, Adam Wolf, and Christopher Field suggested that the Anthropocene began with the human-induced disappearance of Pleistocene megafauna like the woolly mammoth. They argued that the decrease in these large herbivorous species - timed to the arrival of humans in deglaciating areas like Alaska, Siberia, and Yukon - may have led to an increase in the total area of land cover by various species of birch. Doughty et al suggested that this increased birch coverage in turn modified the land surface albedo and led to regional atmospheric heating of up to 1°C. While the evidence to suggest that humans were partially or primarily responsible for the extinction of these species was in itself "highly controversial" (Doughty et al 2010, L15703 page 4 of 5), Doughty and his co-authors nonetheless argued that the Anthropocene should be "extended back many thousands of years" until the thousand year window either side of 13,800 BP to account for the earliest interactions between human-induced change and the biophysical feedback systems of the earth (ibid). Taking a similar line, environmental scientist William Ruddiman - occasionally writing alongside

the AWG's Erle Ellis - produced successive arguments that the Anthropocene be dated sometime between the years 5000-8000 BP to account for the "initiation and intensification of human impacts" that may have caused a "divergence of ice-core CO₂ and CH₄ concentrations from the natural trends predicted by earth-orbital changes" (Ruddiman 2003, p262; also 2007; Ruddiman & Thomson 2001; Ruddiman & Ellis 2009). In Ruddiman's view, the orbital forcing of Croll-Milankovitch cycles alone was insufficient to explain the relative warmth of the Holocene in comparison to the previous interglaciations of the Pleistocene epoch, and this as-yet unexplained warmth was better associated with highly inefficient early attempts at rice agriculture.

Archaeologists Bruce Smith and Melinda Zeder offered an alternative based on 'Niche Construction Theory' (NCT). In doing so they co-opted much of the argument made by various proponents of the Anthropocene - including the AWG - to offer a metanarrative based on the "remarkable ability [of humans] to create new niche-constructing behaviors and to broadly transmit these behaviors across generations through social learning" (p12). More explicitly than either Doughty or Ruddiman, Smith and Zeder attempted to invert the Anthropocene boundary question, such that it reflected the onset of changes, and not the manifestation of those impacts in the sedimentary record. Like the archaeologists and landscape ecologists in the AWG - who professed a more highly granular understanding of the impact of humans over time and space - Smith and Zeder's argument tried to avoid setting a hard lower boundary. More important than attempting to locate the exact point at which humans transitioned from being passive inhabitants to an (aggregated) dominant force able to manipulate the earth in materially evident ways, Smith and Zeder's vision of the Anthropocene was about identifying the point at which humans began to develop the very capacity to alter the earth at a global scale. As a result, for Smith and Zeder it was the initial domestication of plants and animals and the subsequent development of agricultural economies that represented "a major evolutionary transition in earth's history" (Smith 2010, p260). This act of domestication was a "more natural beginning point for the Anthropocene" even if its material stratigraphic legacy was fairly subdued (Smith & Zeder 2013, p12; also Streeter et al 2015, p1663). For Smith and Zeder, NCT resolved the lower boundary question by

sidestepping the issue entirely, taking aim at the inadequacy of “extant geological standards” to account for the causes of change over time (p13).

Among those interlocutors that offered a replacement GSSP for the onset of the Anthropocene, pedologists Giacomo Certini and Riccardo Scalenghe suggested that the ‘golden spike’ for the Anthropocene be located around 2000 BP to reflect combined increases in global population and per-capita land use at that time (Certini & Scalenghe 2011, p1273). They contended that climate variations alone - the mainstay of the Doughty et al, Ruddiman, and the (then) consensus view emerging from the AWG’s early efforts to locate the Anthropocene in the Industrial Revolution (Zalasiewicz et al 2011a) - were insufficient markers of the “global impact of humans on the total environment” (Certini & Scalenghe 2011, p1270). Offering their own alternative, ecologist Simon Lewis and geologist Mark Maslin argued that we consider the collision of Old and New World biotas during the Columbian Exchange from 1492 onwards to be the onset of the Anthropocene. Theirs followed a similar argument by Richard Nevle and Dennis Bird that synthesised the impact of rapid population decline on carbon uptake in the New World (2008). Thus, Lewis and Maslin noted that the mixing of fossil assemblages from that time onwards, the “unprecedented homogenisation of earth’s biota,” and the rapid decline in the human population of the Americas as a consequence of colonisation led to a regeneration of forest cover and a commensurate dip in atmospheric CO₂ levels that could be traced worldwide (Lewis & Maslin 2015a, p175). They paired this ‘Orbis Spike’ - named for the beginning of a connected ‘world system’ in trade - with a second putative lower boundary intended to coincide with the “major expansion in human population, changes in natural processes, and the development of novel materials from minerals to plastics to persistent organic pollutants and inorganic compounds” that took place during the ‘Great Acceleration’ (p176). As a marker for this second lower boundary they offered the 1964 peak in nuclear weapons testing immediately prior to the Partial Test Ban Treaty, and the resulting “unambiguous” and globally synchronous radioactive signal or ‘bomb spike’ that could be located in both ice-cores and tree rings worldwide (ibid).

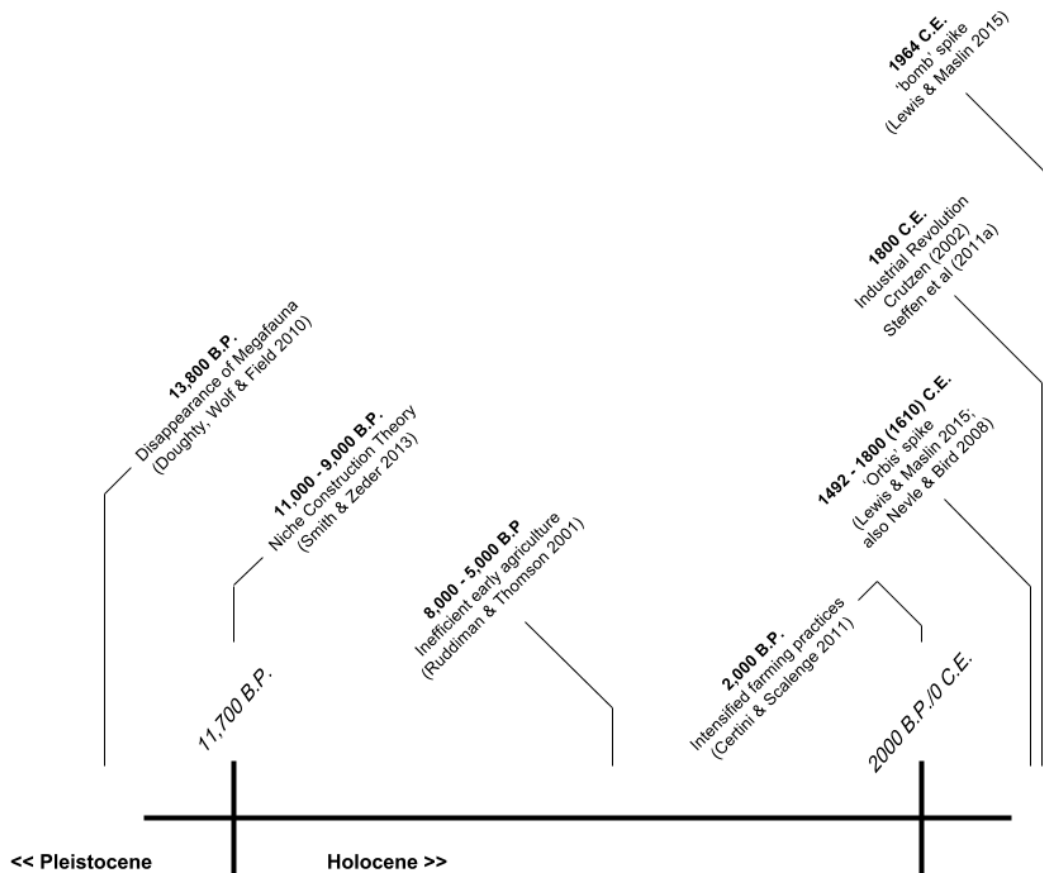


Figure 8: The various timings of the ‘dating controversy’ alongside one another.

By contrast to the above, arguments emerging from the social sciences and the humanities were perhaps less literal in their association to the epochal claim at the core of the Anthropocene argument. Instead, these interventions sought to respond to the political implications of declaring a new epoch by offering a set of alternative terminologies. Commentating on this move, ecosystem scientist Yadvinder Malhi has suggested that for these interlocutors, the Anthropocene and the notion of planetary scale epochal change was a “cultural meme” rather than a discrete scientific object over which to offer commentary, critique, and amendment (2017, p94). Indeed, Malhi has argued that the use of the Anthropocene in the social sciences and humanities suggests that the geological designation ‘~cene’ has become a “semiserious but more often... mischievous ideological provocation” (ibid). Malhi’s Oxford University colleague Jamie Lorimer has similarly called the Anthropocene when used in this way a ‘leitmotif’ (2016,

p117). As a result, these 'variants on the theme' of the Anthropocene arguably share more in common with one another than do the various alternatives outlined above, even where their particular points of provocation differ. All the same, they mark a serious extension of the parameters of the Anthropocene controversy, drawing to the fore and making explicit questions about appropriate authority and expertise and the implications of the Anthropocene concept in a way that was more implicit in interventions over the dating controversy. A pre-eminent example of work in this area is the efforts of historians Christophe Bonneuil and Jean-Baptiste Fressoz, who argued that the Anthropocene and the institutional apparatus that produced it created an "historically false" narrative of change that "depoliticise[d] the long history" of human changes to the planet (Bonneuil & Fressoz 2015, pxiii; also Bonneuil 2015). Bonneuil and Fressoz pointed to a number of dynamics in what they called the "hegemonic" mainstream narrative of the Anthropocene, from the reliance on the Gaia hypothesis - a eco-facist legacy of Cold War-thinking (p58; also Colebrook 2012, p186) - to the pervasive references made to the singular category of 'the human species' in the writings of Anthropocene proponents like the AWG (p68; also Palsson et al 2013; Malm & Hornborg 2014, p67).

Thus, for Bonneuil and Fressoz the terminology of the Anthropocene black-boxed 'the human' as a simplified and abstract construct despite wide differences in the responsibility for and experience of human changes to the planet (p34). If the term and concept 'Anthropocene' stood for these institutional arrangements and their capacity to produce a "managerialist fantasy" that would "represent the world as a totality to be governed" (Bonneuil & Fressoz 2015, p48) then the eight proliferations on the Anthropocene term that they offered - 'Thermocene', 'Thanatocene', 'Phagocene', 'Phronocene', 'Agnotocene', 'Anglocene', 'Capitalocene', and 'Polemocene'⁵⁴ - could provide an alternative vocabulary by which to challenge taken for granted categories and make sense of the "deeper causes and processes... of the entry into thermo-industrial society based on fossil fuels" (p17; also Fressoz 2015; Dalby 2007; 2015b).

⁵⁴ Named for energy, the military, consumption, environmental 'grammar', ignorance, the Anglophonic world, capitalism, and politics respectively.

Without these new ‘grammars’ the hegemonic discourse of the Anthropocene could only serve to reinforce a ‘Modernist’ anthropocentric hubris that separates humans from nature, whatever the better intentions of some of its proponents. Bonneuil and Fressoz justified their engagement on the spectre of ceding the discursive space of the Anthropocene to the “Anthropocenologists,” those ESS scientists and AWG members argued to have transgressed their scientific expertise in order to press the politics of the Anthropocene in unclear terms (Bonneuil & Fressoz 2015; Baskin 2015). Bonneuil and Fressoz’s arguments might have addressed the Anthropocene directly, but they built upon a strong foundation of critical work questioning the political implications of climate change science being expressed in increasingly forceful ways (for example Swyngedouw 2010; Wainwright & Mann 2015; 2013; Nelson 2012; Žižek 2007),

Bonneuil and Fressoz were far from alone in articulating these concerns. Development studies specialist Melissa Leach wrote of her own engagement with the United Nations steering group on their 2030 Sustainable Development Goals to argue that the emergence of the Anthropocene discourse had ushered in a “dangerous new world of undisputed scientific authority and anti-democratic politics” (Leach 2013). In recollecting her interactions with scientists at the UN she noted the limited interest paid to social and political concepts, and the contrasting reverence paid to the kinds of scientific authority that might be levied to make demands on the “right” implementation mechanisms for sustainable development (ibid). Similarly, in justifying their own objections to the ways in which the scientific authority of the Anthropocene might be deployed an ecologist related to me how as part of the 100 person team brought to Venice in July 2009 for the Scoping Meeting of the 5th Intergovernmental Panel on Climate Change Assessment they had expected to hear about the ways in which the Anthropocene conversation was breaking down the barriers of the nature/culture divide. Instead, a prominent physicist among the group opened up deliberations with a presentation about climate science expressed only in terms of physical science. Physical reality was presented as a big blue circle, and “the problems of ecology and society” were presented as “disturbing yellow arrows [disrupting] that beautiful circle” (1x email). Escalating this same objection beyond commentary alone feminist philosopher Chris Cuomo launched a campaign on the

petition website MoveOn.org to present to the organisers of the 35th International Geological Congress, rallying others to an objection that stratigraphic formalisation of the Anthropocene would encourage “fatalism and myths about the wretchedness of human nature” with chilling implications for all of us” (2015a; 2015b).

Similar arguments were made by a variety of scholars including feminist science studies scholar Donna Haraway (2015; 2016a; 2016b; Haraway et al 2016), human ecologists Alf Hornborg and Andreas Malm (Malm & Hornborg 2014; Hornborg & Malm 2016; Hornborg 2015; Cunha 2015), anthropologist Anna Tsing (Tsing 2015; Swanson et al 2015; Haraway et al 2016), environmental historians Jason Moore (2014a; 2014b; 2016), Stephen Pyne (2015), and Justin McBrien (2016), political scientists Robyn Eckersley (2015) and Timothy Luke (2013; 2015), ecological economist Richard Norgaard (2013), sustainability scholars Jeremy Baskin (2015), Ekaterina Chertkovskaya and Alexander Paulsson (2016), and physician Bryan Furnass (2012) at this fuzzy boundary between commentary, deconstruction, and intervention in the Anthropocene controversy. Unwilling to cede the discursive ground to what one participant called “the ‘good Anthropocene’ and geo-engineering crowd” (1x email), each argued - in their own ways - that the ‘Anthropocene’ constituted an inadequate conceptualisation of ecological crisis, was tethered to an inappropriate terminology, and formed an ill-suited basis for a response to the crisis that the Anthropocene was intended to name (see also Crist 2016; Hornborg 2015). For these interlocutors, the framing of the ‘Anthropocene’ as a stratigraphic and ESS concept broached the topic of earth-human interaction in an improper manner by dressing up a series of socio-political problems as if they could be reduced to a singular technical question (Swyngedouw & Ernstson 2017). As a result, the Anthropocene was simply another example by which political and value decisions were being buried beneath the dual veneers of science and objectivity (see Yearley 2001, p464; Mitchell 2002, p221). Much as with Bonneuil and Fressoz, these interlocutors responded to the familiar entrenchment of epistemic privilege in natural science descriptions of the world (Shapin 2010, p379; Lessl 1996, p362; Gieryn 1983, p781), particularly where it concerns environmental management (Yearley 1996, p76).

For example, where STS scholar Andrew Stirling argued that the Anthropocene could not be disentangled from the latent ideology of control implied in the writings of Paul Crutzen and his focus on techno-managerial solutions like geo-engineering (Stirling 2015a, 2015b), his arguments conjoined a longstanding concern of his regarding the role of values in the production, constitution, and interpretation of knowledge (Stirling 2016; 2014a; 2014b). In their efforts to open out the narrative of the Anthropocene and make its value dimensions clear, these scholars - like Bonneuil and Fressoz - offered a range of new terminologies: 'Chthulucene' (Haraway), 'Technocene' (Hornborg), 'Capitalocene'⁵⁵ (Malm and Moore), 'Plantationocene' (Tsing), 'Pyrocene' (Pyne), 'Necrocene' (McBrien), 'Econocene' (Norgaard), and 'Growthocene' (Chertkovskaya). As Donna Haraway has argued, the central 'anthropos' figure of modernist 'Man' was a "parochial fellow [...] too big and too small for most of the needed stories" (Haraway 2016b, p174n4; similarly expressed in Moore 2014a; 2015; Bierman et al 2016; Lövbrand et al 2015). As with Bonneuil and Fressoz, these terms were warranted by "the exclusion" of stories and agencies that "might better have named this time of the Anthropocene that is at stake now" (Haraway 2016b, p100; also Clark, 2012: vi).

Despite the substantive differences in their modes of engagement - alongside quite different conclusions about the value of the Anthropocene as a specifically scientific concept - both the earth and environmental science perspectives and the social science and humanities perspectives outlined above shared a key 'interest' (see Golinski 2005, p24; Gieryn 1983; Pickering 1983; Barnes & MacKenzie 1979) which served to justify their engagement in the controversy. This interest regarded the story told by the Anthropocene, and the need to present a counter-narrative to what they perceived to be a burgeoning hegemonic narrative supported by the institutions of science. As a result a number of these arguments pulled a kind of double duty that makes them complex and intractable artefacts within the Anthropocene controversy: a trend perhaps most clearly

⁵⁵ There appears to be some confusion over who coined the Capitalocene first, be that Bonneuil and Fressoz, Malm and Hornborg, Moore, or even Haraway (see Moore 2016). Given the similarities and the more or less coincidental emergence of this particular reframing it is wholly possible that it is purely chance that all these authors had the same idea at the same time.

exemplified by Smith and Zeder who noted that “perhaps [unsurprisingly], researchers have often found the most significant indicators of the Holocene-Anthropocene transition, and sometimes the only indicators of interest, within the boundaries of their own discipline” (Smith & Zeder 2013, p9), while simultaneously offering up their own version of the Anthropocene based on disciplinary self-interest. As a result, many of the interventions detailed above were both contributions to the controversy in the form of counter arguments, and also (somewhat) self-aware reflexive commentaries on the controversy itself.⁵⁶ These interventions might have been launched in response to the (nominally) stratigraphic output of the AWG, but they were less interested in the details of that stratigraphic argument and more engaged by how that argument transgressed into their own areas of expertise.

For example, in keeping with arguments that they had made elsewhere against the value of ‘universalist theories’ in archaeology (Zeder & Smith 2009; Smith 2012), Smith and Zeder’s argument presented deep scepticism about the value of appointing a singular date to what they regarded to be a more complex pattern of change over time. As a consequence, Smith and Zeder suggested that because the Holocene had already been formalised it should be left as the geological standard for the wholly pragmatic reason that it might retain its value in “scientific contexts” (Smith & Zeder 2013, p13). Instead, they advocated for the adoption of the Anthropocene in a looser sense as a term for “popular discourse” only, one that would serve to “focus attention and research interest on the past ten millennia of human engineering of the earth’s ecosystem” (ibid). In illustrating two putative start dates Lewis and Maslin likewise implied a scepticism about the value of any formal lower boundary for the Anthropocene, arguing that “any chosen date would be potentially open to challenge as arbitrary” (2015; p177). Instead, they suggested that the decision over the appropriate lower boundary for the Anthropocene should be made on the basis of which “stories” ‘we’ wish to tell, and the impact that these stories might have on global society as a whole. Their ‘Orbis Spike’ hypothesis might “highlight the unequal power relations” of colonialism, while their ‘bomb spike’ could serve to “highlight the ability of people to collectively... manage a

⁵⁶ A trap into which my writing also inevitably falls.

major global threat” in the form of nuclear war (p178). Of the two, Lewis and Maslin ultimately favoured the ‘Orbis spike’ because of the way it fit “more closely with Crutzen and Stoermer’s original proposal (p177). While theirs was a thorough argument that they wished to be taken seriously for its stratigraphic merit and expected to be judged on those grounds (see 2015c, p129), a core dimension of their argument related to how an (imagined) audience might respond to and act upon any particular version of the Anthropocene narrative.

Recognising this central appeal to what the Anthropocene concept might mean for those who act upon it illustrates just how much Lewis and Maslin’s argument shares in common with the more outwardly metaphoric Anthropocene variations to emerge from the social sciences and the humanities. As with those interventions that sought to rename the Anthropocene, the ‘framing’ of the Anthropocene itself became constitutive of the kinds of responses that would be made possible through invocation of the concept (Lundershausen 2015, p312). These efforts all sought to square the circle between the ‘universalist’ narrative that the AWG had proposed - one of growing ‘human’ impacts over time and their impact on the earth as a whole - and a more ‘particularist’ narrative that might better account for what that change looked like at any given time and place. As Johannes Lundershausen has noted, the decision to advocate for a more particularist narrative speaks to a desire to “better represent the situations in which the majority of the global population finds itself” (2015, p314). And, in turn avoid the science fictional quality of the AWG’s work and its imagined future audience. As a result, each should be viewed as interesting attempts to compromise on aspects of the AWG’s pitch in spite of the vast disagreements over the implications and value of a specifically stratigraphic reading of anthropogenic change they forward. Of particular note, each moved beyond the claims advanced by the AWG through the introduction of audience modulation to their competing visions of the Anthropocene concept. In so doing, each pushed their discussions of the Anthropocene beyond the space in which the ICS and AWG sought to contain it.

7.3. The Anthropocene as ‘Opportunity’

Despite objections, these interlocutors sought to ‘opportunistically’ (Pickering 1984, p10) make use of the Anthropocene all the same. In one example of many by which commentators pulled double duty in the controversy, both Yadvinder Malhi - who above dismissed the way in which scholars had increasingly come to adopt the Anthropocene (2017, p6) - and Christopher Doughty served as co-authors on a recent paper tracing ecosystem function from “the Pleistocene to the Anthropocene” (Malhi et al 2016), a paper that made reference to the Anthropocene in the title and one subheading but never in the body of the text. Illustrating how interlocutors might occupy multiple positions in the controversy, Certini and Scalenghe responded to criticism of their work by questioning the ‘worthiness’ of any formal geological definition of the Anthropocene, and by withdrawing their symbolic 2000 BP lower Anthropocene boundary. Rather than withdraw from the controversy, they instead embraced Smith and Zeder’s argument that we might consider the Anthropocene as being effectively co-eval with the Holocene (2015a; 2015b). That the Holocene already boasted formal status meant that it was the perfect vehicle to hold this new semantic meaning. In doing so they explicitly rejected a growing clamour to make use of the Anthropocene as an informal terminology (Certini & Scalenghe 2015a; c.f. Ruddiman et al 2015⁵⁷) and instead staked their position on the prospect of retrofitting the normative dimensions of ‘Anthropocene’ to the (nominally) non-political and stratigraphically ‘tangible’ Holocene. Certini and Scalenghe might have concluded that the Holocene be renamed as the Anthropocene - and that the term should effectively gain formal status through the back door for non-stratigraphic reasons - but they did so because “the human footprint on the planet was so distinctive and lasting that the Age of Man must be officially recognized in the geologic time scale” (2015a, p246). Their argument thus revolved around what it might mean to act on that knowledge now, while sidestepping an awkward truncation of the Holocene or the challenge of generating a satisfactory argument for a new line to be drawn in the sand (2015b, p79).

⁵⁷ I return to the question of an informal Anthropocene in the following section.

As a pair of soil scientists drawn into this dating controversy, two of my participants were keen to express and clarify their motivations for engaging with the Anthropocene during interview. They pointed out how their discipline operated within and across the kinds of timescales that the International Chronostratigraphic Chart serves to formalise. Their discipline was - in their view - “faster than geology, and... slower than biology”, making it the perfect tool through which to make sense of the suite of changes that the Anthropocene was said to represent (1x interview). Justifying this view, these interlocutors argued that stratigraphers tend to like ‘hard rock’ and were unsettled by the relative ephemerality of other materials, but, if the Anthropocene was a question of human impacts over geologically recent time periods, then ephemera like soil became a necessary tool for making sense of those changes. While pedological interventions in the Anthropocene controversy were heavily criticised for their failure to account for the specifics of the International Chronostratigraphic Chart (Gale & Hoare 2012, p1493; Smith & Zeder 2013), these interlocutors insisted that it was never their intention to offer a new putative lower boundary. Rather, it was only during peer review that they were “kindly invited... to indicate a quite precise beginning,” a request that prompted them to offer “a symbolic year zero” at 2000 BP that sat between the extremely early Anthropocene options and more particularist GSSPs outlined above (1x interview). In this instance the reviewers possibly sought to use the date as a kind of shorthand that would demonstrate to readers how the particular disciplinary perspective on offer might produce a different answer to the question of when the Anthropocene might be said to have begun, at which point the date took over their argument and created an opening for misunderstanding. Or perhaps - more cynically - the reviewers sought to exacerbate the controversy of multiple start dates at the expense of foregrounding the more nuanced intention of the authors. In either case, the intervention was not understood as an illustration of how the Anthropocene debate might be realistically expanded to include a greater number of disciplinary perspectives, rather the introduction of a discussion about soils was seen as a kind of lazy opportunism by other interlocutors in the controversy who were more interested in advancing their own claims (Gale & Hoare 2012; Smith & Zeder 2013).

It is difficult to decode such and intervention in the Anthropocene controversy, in part, because it illustrates a space between the authors' intention, and the way in which other received and interpreted their work. For the soil scientists above the locus of their concern was not the issue of diachroneity and its implications for the setting of a particular lower boundary for a geological epoch called the Anthropocene, nor even the durations of soils "to testify such an impact" (1x interview). Rather as "witnesses to the Anthropocene" in the here and now, they felt that the Anthropocene only had value if the term was applicable in the political present. In this sense their justification lay in the recognition that their own expertise could and should contribute to "any reasonable" discussion of the Anthropocene (ibid), even as their own sense of the utility of stratigraphy contrasted with that of outspoken voices from within the institutional machinery of the discipline who argued that political intention should have no place in the controversy (Finney & Edwards 2016; Edwards, Harper & Gibbard 2017). In this sense - and despite criticism from others who were also engaged in the controversy - there is little to distinguish such an attempt to open out the Anthropocene discourse from the many other earth science and environmental science interlocutors who launched their own interventions. All shared a broad suspicion over the utility of a coarse delineation of geological time where much more granular data was available. As geologists Whitney Autin and John Holbrook have noted, global change is not defined by "abrupt" events, but by transitions (2012, p60). As far as my participants could see, the difference between many of the proffered lower boundary dates were set to be lost to "the error bar of time" in any case (1x interview).

However, as authors, these interlocutors were nonetheless willing to 'play' with the language of stratigraphy, co-opting the language of golden spikes, and 'the geological epoch' in forwarding their case. Neither was the pair any less guilty of 'trumping up' their own arguments. They noted during interview how their perspective "alone [could] account for... the real beginning of the Anthropocene," (1x interview) leaning into both an exclusionary rhetoric that privileged the perspective of their own discipline above others (see Burchell 2007), and the external reality of the Anthropocene as an objective phenomenon to account for their presence in the controversy. In their later published

work in the journal *Nature* they described the alternative views of others as “ridiculous,” a move they recognised to be deliberately confrontational, but nonetheless believed to have been both an “effective” and necessary escalation to ensure that their voices could be heard in an increasingly crowded controversy (1x interview). In this way, these interlocutors could justify their own engagement as a scrap for survival, and could point to both the lack of representation for their specialism on the AWG, and the lack of broader international representation within that group to justify the steps that they must take to be heard. In their view, theirs was a rare voice in a debate they considered to be dominated by scholars working in the UK, United States, and in Germany. They suggested during interview that for all the “circulation of ideas” that the Anthropocene controversy might represent it was also about grants, funding, and the promotion of careers; a “never ending story” about the recirculation of knowledge and arguments that only served to benefit their “colleagues” in Anglophonic research institutions and Germany who they accused of “collect[ing] a lot of grant money” by attempting to define the Anthropocene’s beginning” (1x interview).

Dismissing the dating controversy to which they had similarly contributed, another participant in this research noted how they viewed the boundary dispute as being “in the truest sense ‘academic’” (1x email), suggesting that while it may be technically possible to offer a boundary and discern that from the geological record, such an effort would be “without any real value in terms of clarifying questions of how nature works” (ibid). Instead, they undercut their own adoption of the concept by arguing that the Anthropocene was a “deliberately provocative term designed to generate publications and press,” and little more (ibid). Expounding a similarly complex relationship with the concept, a co-author in that work described how their own interest was not in redefining the Anthropocene as such, but rather in making a more specific claim about the ecological impacts of large animal extinctions (1x email). That insight - more “fundamentally scientific” - could help generate an understanding how future extinctions might impact ecosystems and would have more value for it (ibid). In each case scholars negotiated an engagement with the Anthropocene that was less about contributing to the concept’s development as a stratigraphic thing, and more about trading off the

visibility of that term on the grounds that other interlocutors were doing this as well. However, by sustaining the argument that neither stratigraphy nor the lower boundary question mattered in the grand scheme of things, these interlocutors also worked to produce their own reinterpretation of what stratigraphic nomenclature was for based on their own interests (see McAllister 1992, 25).

If this represents a complex, and necessarily tangled kind of opportunism, it was equally visible in social science and humanities interventions in the Anthropocene naming controversy even if it was generally couched in terms of a greater awareness of the “opportunity-challenge” that the Anthropocene presented for scholars (Cook et al 2015, p231). That is, these interlocutors were perhaps better aware - or at least better able to articulate - their rationale for engaging with a concept they recognised to be problematic but wished to explore all the same.

The suffix “-cene” proliferates! I risk this overabundance because I am in the thrall of the root meanings of -cene/kainos, namely, the temporality of the thick, fibrous, and lumpy “now,” which is ancient and not.

(Haraway 2015, p163)

In this way, interlocutors understood their own efforts to reconfigure the Anthropocene nomenclature as both legitimate attempts to explain “‘the real drivers’ of coupled human-natural change,” and effectively ‘free rides’ on the back of the Anthropocene and its burgeoning popularity (1x email). Like Smith and Zeder who conceived of the Anthropocene as an “initiative” to draw attention to environmentally sustainable management of the environment rather than as a wholly credible stratigraphic thing (Smith & Zeder 2013, p8), interlocutors in the naming controversy were less interested in particular stratigraphic arguments over the Anthropocene. Indeed, in recognising that Crutzen “couldn’t possibly have thought through all the stratigraphic implications” they drew authority from Crutzen’s own inattentiveness to the particulars of the International Chronostratigraphic Chart to justify their own reconsideration of the Anthropocene in non-stratigraphic terms (1x interview).

In their efforts to be heard some influential scholars also demonstrated a tendency to overstate the scientific authority of the AWG's arguments and the particular disciplinary formations at play. For example, as Donna Haraway suggested:

The Stratigraphic Commission of the Geological Society of London will give its decision in 2016 as to whether Anthropocene will become a term to replace the Holocene as a geological epoch, and my guess is that they will say 'yes'. And I am sort of for it, because I do not see any alternative now.

(Haraway et al 2016, p539)

Cultural theorist Claire Colebrook likewise suggested that the 'hegemonic narrative' of the Anthropocene was "close to consecrated" (2014). While the Stratigraphic Commission of the Geological Society of London did perform a preliminary stratigraphic analysis of the Anthropocene (as Zalasiewicz et al 2008), the ability to make a final decision on the Anthropocene as a formal geological epoch has always rested with the ICS and the IUGS, and has always been subject to a supermajority vote. And, while the AWG produced a widely reported internal vote on the matter (University of Leicester Press Release 2016), those with the requisite expertise in the process of stratigraphic formalisation noted both publicly and privately that the AWG were yet to submit a formal proposal to the ICS (see Finney & Edwards 2016) or build the necessary bridges within the Quaternary science community to ensure that formalisation was even on the cards when Haraway made this claim (1x interview; 1x email). Nonetheless, in her book *Staying with the Trouble: Anthropocene, Capitalocene, Chthulucene*, Haraway repeated this claim, acting as if the formal stratigraphic debate were settled when it demonstrably was not (2016b, p188n44). While I am sympathetic to Haraway's core concern, this inattentiveness to the particulars of the stratigraphic argument for formalisation sought to foment among certain audiences a sense that there really was a dominant and unquestioned Western Male scientific elite orthodoxy at play in the production of the

Anthropocene that had failed to account for marginalised stories. That is to say, the very tension to which Haraway wished to respond.

With such high stakes in play it became a kind of 'reconstructivist' activism (see Woodhouse et al 2002) in the eyes of critical interlocutors to borrow the language of the Anthropocene and undermine the "coveted objectivity" of the Anthropocenologists (1x email; 1x interview). Casting themselves as a concerned citizen as much as a scholar of ecological economics, one interlocutor made clear to me their concern that it mattered less which epoch we are in so much as "how the conversation about epochs [allowed] the Anthropocenologists and the scientific community to complain about the implications of economic growth without engaging in the social science domains of economic critique" (1x email). In this sense, by using "their words" (ibid; also 1x interview), interlocutors created an opening by which to expand the conversation to include lines of critique that were otherwise squeezed out. Thus, in illustrating the spaces in which their own distinct expertise could make its most valuable contribution these interlocutors pointed to the various ways in which the Anthropocene was not simply a technical question but rather a "cultural one," connected to ideas including 'control over nature', 'notions of beauty', 'ideas about proper estate management', and 'conspicuous consumption' (Kelly 2016; Pawson 2015; Palsson et al 2013; Szerszynski 2012). Recognising the same tension to 'do' something with the concept, interlocutors felt obligated to offer alternatives to the "gloomy Anthropocenic futures" conjured by the hegemonic Anthropocene narrative (Garrard, Handwerk & Wilke 2014, p150). In this way the Anthropocene came to resemble a kind of "crisis discipline" (Lorimer 2012, p594), a necessary space through which to respond to an ecological crisis that transgressed multiple imaginative registers and moved away from the limitations of any formal stratigraphic settlement for the term.

Nonetheless, there was something particular about the renaming the Anthropocene as it occurred amongst interventions that originated in the social sciences and humanities. While a reconfiguration like 'Capitalocene' - or any other - was intended to crack open the homogenising politics of 'anthropos' for its intended audience, it did so by knowingly

tethering itself to the Anthropocene concept and the presumed authority of that term. The intention appears to have been to play with the term, recognising the plasticity of all terminologies and leveraging this with the intent to illustrate an understated dynamic of global change. However, as a result of their very playfulness, these interventions arguably served to reinforce the very same authority they intended to push against. For example, Capitalocene was only visible as a result of that tethering, and only comprehensible by reference to the Anthropocene, the term it sought to subvert. If interlocutors intended to make people rethink the implicit politics and normative values of the hegemonic Anthropocene narrative as it moved through intellectual life then they had the unenviable task of explaining the Anthropocene in full before they could even begin to voice their own objections. In effect, Capitalocene was both subversive of and subservient to the Anthropocene at the same time.

It is perhaps unfair to differentiate this subservient dynamic as it was at play amongst those who sought to rename the Anthropocene from that same tendency amongst interlocutors who sought 'only' to offer alternate lower boundaries. In both instances interlocutors rode on the visibility of the AWG's efforts to transmute the Anthropocene into something new, yet by altering the name and the frame of reference, these renamings in particular created a peculiar arm's length relationship with the concept that the AWG had produced. It arguably had the effect of reinforcing the sense that the AWG's stratigraphic argument existed in a separate and black-boxed space reserved for natural science input. I note that critical interlocutors like Alf Hornborg also appeared reluctant to be seen to criticise the physical reality of the Anthropocene, conceding the "incontrovertible" reality of anthropogenic change even as he attempted to shift responsibility for that change away from 'humans' and on to socio-economic processes (2015, p57). Another interlocutor voicing similar criticisms of the AWG's hegemonic narrative was keen to stress to me that it would be "uncharitable" to ignore the role of the natural sciences in pointing out the physical reality of change, and the good work that had done (1x email). As a consequence, these attempts to reconfigure the Anthropocene in order to overcome the culturally privileged position of science also constituted a kind of 'reciprocal validation' (see Wynne 1998, p73) because they wanted

to build on those claims rather than restructure them entirely. That is, they both reinforced the argument that they sought to deconstruct, and they made that argument more visible than it might otherwise have been.⁵⁸

7.4. Disciplinary Invisibility

Despite the wide-ranging response to the Anthropocene detailed above, not every interlocutor in the controversy responded with an attempt to alter, adapt, or change the concept. In a high profile intervention, Director of the Climate Change Consortium of Wales - James Scourse - criticised the efforts of both the AWG and those who had responded to the AWG's work as having "stimulated a redundant, manufactured, debate that displaces more important scientific research and genuine discussion on climate and environmental change" (Scourse 2016, online). For Scourse, the Anthropocene was nothing more than a fad and a bandwagon, "a way of marketing research as cutting-edge and relevant..." that at its worst could be "seen as a disingenuous means of harvesting citations under the guise of serious endeavour" (ibid). Although Scourse's argument was replicated elsewhere - albeit by less prominent authors (see Westcott 2015; Smil 2015) - it was a difficult one to sustain because it was so self-contained and had little need for elaboration. After all, Scourse simply argued that we stop with this "nonsense" and move on to something else (ibid). But, while Scourse might reject the Anthropocene wholesale, other interlocutors developed a more complex set of

⁵⁸ Ruddiman appears to be an outlier in all this, having initially appeared to avoid the term Anthropocene by referring to his arguments in terms of an 'early anthropogenic hypothesis' rather than making specific reference to the Anthropocene (Ruddiman & Thomson 2001; Ruddiman 2003; Ruddiman & Ellis 2009). Thus, in considering how Ruddiman's arguments about early global-scale anthropic influence created implicit problems for the Anthropocene narrative, it appears to have been others that drew Ruddiman into the controversy in explicit terms (for example, Crutzen & Steffen 2003, p252; Clausen et al 2005, p405; Smith & Zeder 2013, p11). It was only after others brought Ruddiman into the controversy that he made use of the term himself (Ruddiman 2013; 2015) - with limited commitment beyond suggesting that the term "is clearly here to stay" and might have value as "an informal term" (Ruddiman et al 2015, p39). After a pair of interventions in 2015 (as Ruddiman 2015; Ruddiman et al 2015) Ruddiman withdrew from the Anthropocene controversy by no longer making use of the term as a title or a keyword for his own efforts. Critically, Ruddiman did not withdraw his arguments for early anthropogenic influence. Instead he actually reaffirmed the value of his empirical argument by noting its slow adoption and acceptance of early anthropogenic influences in the literature (2016a; 2016b), and by drawing on Karl Popper to assert the 'unfalsifiability' of his claims (2016a; forthcoming).

relationships with the concept that neither completely rejected the Anthropocene nor fully endorsed it.

An interesting example of this trend was the British Society for Geomorphology's Fixed-Term Working Group on the Anthropocene (hereafter the Fixed-Term Working Group). While members of the group had previously encountered the Anthropocene in scientific literature, the impetus to come together and consider the concept in a more organised way came in 2008 or 2009 when a "famous writer" said to the host of BBC Radio 4's *Today programme* "well you do realise of course we're now living in the Anthropocene" (1x interview). Thus, recognising that the Anthropocene had spread beyond a simple academic curiosity into something larger, members felt obligated to produce a serious response. Around the same time, other members had begun to notice that geomorphologists were increasingly producing "intellectually lazy work" by simplifying their research to accommodate the Anthropocene (1x interview). As one member recalled, their concern lay in the recognition that geomorphologists were beginning to discuss their own specialist area - dry eroded watercourses called 'dongas' - as if they were solely the product of anthropogenic influence despite very limited empirical evidence to support such a claim. In a similar vein, this member noted that large parts of the Southern Hemisphere were being enrolled into the globalised narrative of the Anthropocene with their local specificities being overlooked. For members this laziness was indicative of a "mushrooming" of use of the Anthropocene concept, one wholly ungrounded in any clear consideration of the meaning of the term, its value for geomorphology, or its implications for the discipline (2x interviews). One member seemed particularly suspicious of the funding implications of stratigraphic formalisation because the designation of some research as 'pre-Anthropocene' might leave it on the wrong side of an "imaginary dividing line" before and after the point of 'overwhelming' human influence (1x interview). Therefore, the decision to actively engage with the Anthropocene was consistent with a broader sense of exclusion from contemporary environmental science debates that had left geomorphology an "invisible" discipline (ibid). As Fixed-Term Working Group member Stephen Tooth had previously argued, geomorphology was increasingly being subsumed by "bandwagons such as earth

system science” leaving it hard to assert the distinct contribution of the discipline and its focus on the formation of topographic features at the earth’s surface (Tooth 2009, p754).

Armed with five year’s of funding, 12 members in hand, and a genuine belief that they might affect the final outcome of the Anthropocene controversy (1x interview) the Fixed-Term Working Group became the most structured and substantive effort to produce a response to the AWG’s efforts. Like the disciplines of ecology, pedology, environmental science, and archaeology, geomorphology unavoidably presents a picture of growing human influences over time. But even then the Fixed-Term Working Group noted the difficulty of delineating natural and artificial forcings across a range of environments. While coastal and fluvial geomorphologists might have to contest with extensive human impacts, the group noted that the extensivity of human influences would be less clear to glacial, periglacial and aeolian geomorphologists (Brown et al 2017, pp 73-78). In an argument reflected elsewhere by stratigraphers logging their own objections to the Anthropocene (Autin & Holbrook, 2012a, p60), the group argued that the AWG’s vision of the Anthropocene presented a false narrative of change, where in practice it was difficult to discern where natural forcings end and artificial forcings began, and harder still to construct reliable cause and effect narratives across time-transgressive boundaries (Brown et al 2009b, p85). Suggesting that this was a persistent concern for scientists whose work lent them intimate familiarity with the geological recent past, participants in this research from both Quaternary science and archaeology similarly pointed out how “scientifically retrograde” it was to offer a course description of a forest on the horizon when we were effectively standing amongst the trees and could offer a far more complex picture (1x interview; similarly expressed 1 further interview). These objections related to a broader push against the misuse of the formal stratigraphic column amongst geologists and Quaternary scientists who felt that data-led science could tell more “fiercely complex” stories than distinct boundaries alone could convey (for example Boulton 2012, p677). While the British Geological Survey had recently argued that formal categories actually support efforts to enhance modelling precision and the use of more granular data (see McMillan & Meritt 2012), those working on more

recent environments expressed concern that where formal classifications were used as the basis of modelling efforts they had the effect of pulling everything into artificial boundaries and disregarding “the real temporal variation” that was initially used to construct those boundaries (1x interview).

For their part, the Fixed-Term Working Group targeted the use of the terms “overwhelming” and “dominance” to describe anthropic influence as it appeared in the AWG’s output (Brown et al 2017, p73), an “unquantifiable argument” that ignored the fact that ‘first-order processes’ like the precessional cycle, volcanic activity, and plate tectonics were still the truly dominant drivers of the earth system (p84). The result of the Fixed-Term Working Group’s efforts was a pair of papers published in the in-house journal of the British Geomorphological Society, *Earth Surface Processes and Landforms* (as Brown et al 2013b and Brown et al 2017) alongside a position paper for the society itself. The Fixed-Term Working Group’s final position was a strong rebuttal to the idea of a formal stratigraphic Anthropocene and argued that “formal identification essentially would be arbitrary and impractical under existing stratigraphy procedures and would be very unlikely to garner universal or even majority support amongst geomorphologists or the wider geoscience community” (Brown et al 2017, p85). Despite their objections, the Fixed-Term Working Group’s position paper ultimately advocated for a specifically ‘informal’ Anthropocene (Brown et al 2017, p85). For members, then, “there [were] pluses and minuses, and you [had] to calculate whether they [would] equal out” (1x interview). The “genie [was] out of the bottle,” and even if this was not reason enough to formalise the Anthropocene, it made it hard to halt the further spread of the term (ibid).

While their investigation provided the opportunity to consolidate a range of frustrations, the challenge moving forwards was to make use of the term in whatever way would best facilitate meaningful research. One member pointed to an on-going grant application that “of course [made] use of the Anthropocene” to look at ancient agriculture and DNA (1x interview). In this setting the Anthropocene served to appease the funding body and assure them of the contemporary relevance of the proposed work even if the term was

“scientifically bunk” (ibid). Similarly, another member pointed to art-science collaborations that had made use of the Anthropocene as a “convenient vehicle for getting people interested in human impacts” (1x interview). Simply put, expressions of human change become “stale and tired...a bit old hat” and there was undeniable value in maintaining interest in those conversations through the introduction of an arresting new terminology (ibid). In short, the Anthropocene was “too philosophical” and non-scientific, subject to the possibility of “parameterisation” via geology, but ultimately irresolvable. As a result, the group’s efforts sought to render the Anthropocene a communicative metaphor more so than a specifically scientific - or stratigraphic - concept. However, it was exactly that irresolvability - the way the Anthropocene could provoke open-ended questions about the place of humans on earth - that gave the Anthropocene a kind of metaphoric reach even as that very looseness left it unsuitable as a scientific concept (ibid). Thus, by forwarding their own position, the group hoped to help encourage a wider conversation within geology, the earth sciences, environmental science and geography more broadly (1x interview). They might not have done this for strictly ‘scientific’ reasons, but as geomorphologists they could either “jump on board and contribute, or let the conversation take place [without them]” (1x interview).

Following the same logic, physical geographer Karl Butzer warned in the journal *Holocene* that scholars should avoid the Anthropocene as an alarmist framing that would “blind” them to the fact that natural events like Pleistocene glaciations “posed more severe tests for biotic evolutionary success” than did contemporary change caused by human action (Butzer 2015, p1541). Butzer implied that the Anthropocene had emerged as a consequence of virtue signalling over the recognition and attribution of causality in global change. In Butzer’s view, by lending support (tacit or otherwise) to the prospect of Anthropocene formalisation, scholars were doing little more than attempting to demonstrate that they took the problem of human impacts seriously. In response, Butzer warned that the Anthropocene posed problems for the science of human impacts and had only limited scientific appeal in the context of the “dynamic menu of on-going changes” that characterise the recent past and the present (ibid).

However, as above, Butzer ultimately endorsed an informal version of the Anthropocene:

Anthropocene is not a pretty word... but there is indeed a need for something like it.

(Butzer 2016, p1539)

As with geographers Ian Fuller, Mark Macklin, and Jane Richardson - who made much the same argument in the journal *Geographical Research* (as Fuller et al 2015, p267) - Butzer encouraged scholars to adopt the Anthropocene, despite its limitations, as “a flexible, time-transgressive concept” (2016, p1539).⁵⁹ Like those actively engaged in arguments about the appropriate date and name for the Anthropocene, there existed a broader community of scholars who rejected the prospect of stratigraphic formalisation and yet appeared to acknowledge the momentum behind the spread of the term. Unable to push against the term completely, they recognised the capacity of an informal Anthropocene to convey something of the magnitude of human impacts on the planet to some imagined audience. As a result, they reacted to the AWG’s mainstream vision of the Anthropocene and its capacity to colonise their own discursive spaces by

⁵⁹ For the sake of balance it is worth recognising that some interlocutors were less concerned with offering a specific critique of the Anthropocene or the AWG’s efforts. Starting from the proviso that “the beginning of the Anthropocene is more controversial than its existence” (Foley et al 2013, p84) the term ‘palaeoanthropocene’ was created by scholars who - like the members of the Fixed-Term Working Group - recognised the complicated relationship between human impacts and the environment in the period prior to the “crescendo in anthropogenic effects” that marked the onset of the Anthropocene proper during the ‘Great Acceleration’ (p87). The ‘palaeoanthropocene’ was pitched at the same deliberately ‘informal’ register as Butzer’s suggestion and was intended by its authors to augment the Anthropocene proper without directly “competing” for geological recognition (1x interview). This particular variant found some favour with environmental archaeologists performing highly localised studies (for example Streeter et al 2015). As with the suggestions of the Fixed-Term Working Group or Smith and Zeder’s NCT, the palaeoanthropocene sought to circumnavigate the “boring” boundary problem of the stratigraphic Anthropocene (1x interview) by ignoring it completely. And, as with the members of the Fixed-Term Working Group, adopters of the palaeoanthropocene had a complex relationship with the notion of stratigraphic formalisation by which they seemed to regard the Anthropocene as nothing more than a “meaningless... thought experiment... to be lost to the margin of error when viewed from the future” (ibid), over which “quaint [geologists]... in [their] comfortable little bubble [would] tie themselves in knots” (1x interview). By way of contrast, however, the original authors of the palaeoanthropocene actually hoped that it would help to “preserve” the original meaning of Paul Crutzen’s Anthropocene against the increasing adoption “by a number of people to mean wholly different things” who wanted to draw “economics, law... these other things [into] the discussion” that was supposed to be about physical impacts on the planet (1x interview).

problematise that science, and then endorsing the concept all the same for its rhetorical power.

7.5. Conclusion

Rather than a simple discussion for the AWG and the institutional machinery of stratigraphy about what does or does not constitute a truly stratigraphic investigation, the above sketches a picture of the expansion of the Anthropocene controversy into a far broader arena. As I have shown, a number of interlocutors across the earth and environmental sciences and the humanities and social sciences engaged with the AWG's work on the Anthropocene in ways that might be outwardly familiar to stratigraphers. Their questioning of the proposed lower boundary for this putative new epoch and the questions they asked of the appropriateness of the term 'Anthropocene' mirrored the stratigraphic concerns raised elsewhere by ICS Executive Chair Stan Finney (2014; Finney & Edwards 2016). However, these interlocutors were less interested in an Anthropocene stratigraphy than they were in the implications of the AWG's efforts for their own areas of expertise. Interventions from the earth and environmental sciences rejected both the Anthropocene onset offered by the AWG, and the arguments and methods used to produce that lower boundary. They felt that their own disciplinary perspectives could contribute to a more detailed and more precise narrative of human change on the planet with greater relevance in the political present than could a formal stratigraphic division. Interventions from the social sciences and humanities saw the Anthropocene as another example of the epistemic privileging of the natural sciences (Shapin 2010; Lessl 1996; Gieryn 1983) and raised questions about the governance implications of such a powerful and authoritative framing. For these interlocutors, the Anthropocene had taken a complex topic that ought to have been subject to an open discussion about politics and values and attempted to present it as if it were a simple technical question. Their interest was followed by input from an even broader range of disciplinary actors like the British Society for Geomorphology Fixed-Term Working Group who recognised the impact that the popularisation - and potential stratigraphic formalisation - of the Anthropocene could have upon their own disciplines.

Perceiving themselves to represent smaller disciplines under threat of erasure at the hands of a bigger discipline with greater public authority and greater institutional support, these interlocutors sought to make the best of a situation they viewed as being beyond their own capacity to control. Much as the AWG had initially responded to the burden presented by others encroaching upon 'their' area of expertise, the above communities each sought to 'opportunistically' rearrange (Pickering 1984) the Anthropocene to capitalise on its ascendance and to assert their diverse disciplinary interests. Their solution was to adopt the Anthropocene as an 'informal' concept, one that recognised the impacts of humans on the planet, but would not attempt to define that in stratigraphic terms. Far from subverting the Anthropocene, I have argued that this interest had the effect of both increasing the visibility of the concept and of changing its function in scholarly discourse. In this sense, critical interest expanded the Anthropocene beyond an epistemic burden for stratigraphy alone and into a broader and looser kind of discursive thing. In the following chapter I consider the impacts of this more informal vision of the Anthropocene and its implications for the controversy as a whole.

Chapter 8: Discursive Space, Epistemic Friction, and the Fractional Coherence of the Anthropocene

8.1 Introduction

In the previous chapter I explored how a range of interlocutors responded to the Anthropocene arguments presented by the AWG. I noted the complex motivations and justifications that led scholars to engage with the controversy and I demonstrated how their efforts helped to move the Anthropocene away from a specific scientific framing towards something looser. In this chapter I build upon the last by exploring the implications of this broader vision of the Anthropocene and by questioning the multiplicitous and ‘fractionally coherent’ (Law 2002, p8) nature of the discourse that emerged as a result. In doing so I consider the lock in of the Anthropocene as a discursive space by a range of interlocutors seeking to work with - rather than against - the Anthropocene and consider how this more discursive space was stabilised by the creation of a number of dedicated Anthropocene journals. Situating this push within a ‘managerially driven’ (see Osborne 2013, p83) and contemporary push to ‘be interdisciplinary’ (Barry & Born 2013), I note how these journals were less interested in the role of the Anthropocene as a question for stratigraphy than they were in the possibility for the Anthropocene to foster a particular vision of ‘transdisciplinary’ scholarship. Despite both creating the space for and giving standing to a much looser vision of the Anthropocene, these journals alone could not resolve more fundamental differences in the adoption and use of the Anthropocene by scholars operating within different communities and across different cultures of inquiry. Instead of creating a space for different perspectives to meet, I argue that the discursive vision of the Anthropocene established in these spaces instead served as site through which disciplines might be brought into conflict over longer standing issues relating to epistemic privilege and the use of language. As a consequence, scholars were unable to move the Anthropocene controversy towards a universally satisfactory conclusion

and instead favoured the productive ambiguity of a concept whose definition was held in flux. The uneasy settlement of a dual-life between the formal and informal, and geological and cultural dimensions of the controversy left the Anthropocene without any particular disciplinary anchor. Because interlocutors still drew cachet from the formal debate led by the AWG, the vision of the Anthropocene I describe here continues to illustrate the complex boundary between the scientific and non-scientific dimensions of the Anthropocene concept, and the role of non-scientific thinking in justifying the deployment of scientific framings in the Anthropocene controversy.

8.2. 'Lock in' and the Stabilisation of Discursive Space

As economist Paul David notes in his discussion of the ascension of QWERTY keyboards as the standard layout for typists, it was cheaper for non-QWERTY manufacturers to switch their hardware than it was for them to stick with their own products. In effect David illustrates that far from an 'historic accident', absent an alternative that could be readily accessed, type-writer manufacturers could not shoulder the relative costs of training new typists who could use their own proprietary systems in addition to understanding QWERTY (David 1985, p336). It was easier for rivals to adapt to that system than it was to create a new system from scratch and expect that others might be willing to move away from a system they were already familiar with. As a result, the industry prematurely 'locked into' "the wrong system," after which decentralised decision-making simply sufficed to hold it in place (ibid). So too with the Anthropocene. As the previous chapters have made clear, interlocutors recognised a range of issues and limitations with the concept. However, as a number of participants - each making use of the Anthropocene to explore ecological crisis and how to respond to it - made clear, there was greater value in working "critically within" the concept than there was in rejecting it outright (1x email; similarly expressed 2x interviews). That the term had been driven to prominence presented disciplinary actors with a challenging problem, they could either capitalise on a "fad" in rapid ascension or wait and "lament missed opportunities when [the term was] adopted by other disciplines and [became] the convention" (Cook et al 2015, p231). Just as members of the British Society for

Geomorphology Fixed-Term Working Group had noted that the “genie [was] out of the bottle” (1x interview), other scholars engaged by the Anthropocene noted the need to simultaneously respond to and make the most of the concept’s emergence, figuring out for themselves the “delicate balance between intellectual desire and practical necessity” (1x interview). Without a single central authority - beyond the possibility of formal ratification at the hands of the International Commission on Stratigraphy - interlocutors had allowed the Anthropocene to lock in despite their objections.

Recognising the inevitability of this lock in, the Anthropocene received further attention in the form of special editions and commentary in a range of different journals. These included *Oxford Literary Review* (Clark 2012), *Geography Compass* (Castree 2014a), *Environmental Humanities* (Garrard et al 2014), *Dialogues in Human Geography* (Castree 2015), *Environment and Society: Advances in Research* (Moore 2015), *Geographical Research* (Cook et al 2015), *Cultural Anthropology* (Howe et al 2016), and *Global Environmental Change* (Brondizio & Syvitski⁶⁰ 2016). This attention was further evidenced in a range of conferences including: ‘Anthropocene: Arts of Living on a Damaged Planet’⁶¹, ‘Geographies of the Anthropocene’⁶², ‘Repositioning the Social at the Heart of the Anthropocene: A Transdisciplinary Dialogue’⁶³, ‘How to Think the Anthropocene’⁶⁴, ‘Reason and Affect in the Anthropocene’⁶⁵, ‘Anthro-Obscene’⁶⁶, ‘Stories of the Anthropocene’⁶⁷, ‘Knowing the Anthropocene’⁶⁸, alongside dedicated sessions within larger conferences like the 2016 Society of the Social Studies of Science/European Association for the Study of Science and Technology joint conference in Barcelona⁶⁹. Despite the critical gaze offered at these events, the Anthropocene served as a central organising concept. As Haraway noted when voicing her own interventions, the term had become “mandatory” to all ‘our’ thinking (2016b,

⁶⁰ James Syvitski of the AWG.

⁶¹ 8-10 May 2014, Santa Cruz.

⁶² 2-4 September 2015, Exeter.

⁶³ 30th October - 1st November 2015, Kent.

⁶⁴ 5-6 November 2015, Paris.

⁶⁵ 19-20 May 2016, Copenhagen.

⁶⁶ 17-19 September 2016, Stockholm.

⁶⁷ 26-28 October 2016, Stockholm.

⁶⁸ 26-28 August 2017, Tuebingen.

⁶⁹ ‘Stoking the Anthropocene’.

p45), and it was in recognition of this on-going spread that interlocutors were able to further justify their own need to respond. At the centre of these efforts lay a claim that the Anthropocene was an opportunity for ‘inter~’ or ‘trans~’ disciplinary work (for example Kelly 2016), in order to “extend the conversation” and prevent it being reduced to a question for stratigraphy alone (Castree 2014b; Lövbrand et al 2015). The Anthropocene was a call for collaboration from the ‘hard sciences’ - “the apex of the [institutional] hierarchy” of knowledge production - to the social sciences and the humanities (Haraway 2016b, p100). And, scholars must use that opportunity to “rethink and reshuffle disciplines in order to craft an academe suitable for the gigantic task ahead” (Palsson et al 2013, p3). In this way, critical interlocutors in the environmental humanities were driven by the possibility of “dialogue” across disciplines and the hope of “making common cause” with an unseen faction of natural scientists who were said to have their own “radical criticisms of the status quo” (1x email).

Sustained by this burgeoning interest in the Anthropocene, the period between 2013 and 2015 saw the establishment of three Anthropocene-centred journals, *Anthropocene* and *The Anthropocene Review* in 2013, and *Elementa: The Science of the Anthropocene* in 2015. These journals were not simply passengers to the spread of the Anthropocene, rather each helped to cultivate and stabilise a particular space through which the Anthropocene could be channelled and discussed. In this sense, these journals helped “to make what they purport[ed] merely to announce” (see Schaffer 2013, p57; also Taylor 1996, p181) by creating what contributors viewed as a kind of ‘safe-space’ in which differing perspectives on the Anthropocene could be brought into productive and creative tension (2x interview). Their existence also served as a material signifier for the Anthropocene controversy itself, and commentators began to point to the way in which these journals gave the controversy a tangible presence (Lorimer 2016; Lundershausen 2015; Moore 2015; Purdy 2015a; Trischler 2015). Following the expanded scope of writing on the Anthropocene, the editorial lines of these journals set up the ‘Anthropocene’ as a discursive frame, rather than a scientific fact. For the journal *Anthropocene*, the title was intended as a “broad metaphor to denote human interactions with earth systems and [did] not imply endorsement for a new geologic

epoch” (Chin et al 2013, p2). While the journal would deal with stratigraphic arguments, including arguments about the role of uniformitarianism in the practice of modern stratigraphy (for example Knight & Harrison 2013; Baker 2013), they also targeted more avowedly ‘environmental’ issues of negligible geological significance like the 2011 Fukushima Dai-ichi Nuclear Power Plant accident in Japan (Chartin et al 2013; Kitamura et al 2014; Lepage et al 2016; Satou et al 2016) and the Deepwater Horizon oil spill (Daly et al 2016) as part of a broader focus on local studies and geomorphology (for example Coughlin et al 2015; Romanin et al 2015; Saunders et al 2013). *The Anthropocene Review* cautioned that use of ‘the Anthropocene’ did “not rest on the issue of exact equivalence to past epochs in a formal sense,” but on the broader dramatic “physical and biological changes caused by human activities” (Oldfield et al 2013, p2). And, *Elementa*’s equivalent - an introductory video - spoke of the ‘era’ of the Anthropocene. One of the editorial team at *The Anthropocene Review*, made clear a reluctance to commit to any particular definition for the Anthropocene lest that limit the discursive possibilities of the concept:

If somebody held a gun to my head I would probably be inclined to say it's a concept that motivates a very wide range of people, from philosophers interested in environmental ethics, and artists, and god knows what at one humanistic end of the spectrum, to climate modellers at another end of the spectrum. Whatever motivates them to take very seriously the role of humans in the earth system, and the future consequences of that role.

(1x interview)

An editorial board member at *Elementa* likewise noted during interview that the journal was more interested in the Anthropocene as a call-to-arms and a space for shared learning than the specific stratigraphic investigation led by the AWG (1x interview). Case in point, of the 175 articles that *Elementa* had published as of August 2017 only 7 referred to the Anthropocene directly, and only one article - co-authored by the AWG's Erle Ellis (Ellis et al 2013) - made reference to the question of a stratigraphic lower boundary. In this way the editorial team at *Elementa* wanted to hold onto “the broadest

possible view on the definition of the Anthropocene” (1x interview). Treating the Anthropocene as a ‘provocation’ from the off, this member of the editorial team raised questions during interview about the role that stratigraphy could even play for the conversations that *Elementa* wished to have (1x interview).

In this view the Anthropocene presented insurmountable challenges for stratigraphy as regarded global change research, and it would have limited the space that the journal could cultivate if the editorial team were limited to a purely stratigraphic reading. In a sense, stratigraphy had come to the party late, and was only now recognising changes that were “universally accepted,” “uncontroversial,” and that other disciplines had already accounted for (1x interview). As this editorial board member put it when they had started their career as a geologist they were taught to believe that “human actions simply interfered with [a geologist’s] ability to look at [underlying] geological processes” (1x interview). Concerned that old-fashioned thinking could inhibit recognition of the profound impact of humans on natural processes, this editorial board member explained how a previous generation of geologists had been inculcated to practice their discipline as if the natural and social worlds operated at such incommensurate scales that scientists need not consider the two alongside one another. For example, the artificial damming of rivers made it harder to understand how rivers were ‘supposed’ to work. If the Anthropocene had produced a disjunction between stratigraphy and the known particulars of global change, then that disjunction had arisen from the failure of stratigraphy. It was not the journal’s fault - nor that of the many other scholars who had been drawn to this new concept - that stratigraphers had been unable to overcome their “old-school” perspectives on the significance of human impacts (ibid). The journal’s editorial team might have believed that the Anthropocene concept could force stratigraphers to confront the reality of anthropogenic global change, but in supporting the non-stratigraphic conversation about human impacts they had in mind the journal was also willing to overlook the implications of adopting a piece of stratigraphic-sounding nomenclature to do that work. The term itself was - by the editorial team’s admission - wholly replaceable (1x interview). The term ‘Anthropocene’ itself carried no obligations for the doing of environmental science and were it not for the emergence of

that particular term then the journals editors would simply have “come up with another” to allow the work of the journal to continue with the same editorial vision (ibid). Having attended the Cuernavaca meeting in Mexico during which Crutzen had initially conceived of the Anthropocene as well as having worked alongside the IGBP in the intervening years - and thus having traced the development and growth of the concept for themselves - one of the editorial team at *The Anthropocene Review* could conceive of a space between the ‘Anthropocene’ terminology and the thinking and concepts that sat beneath it. As they noted during interview, “the idea of the Anthropocene, for sure, didn't come to me before it was introduced by Crutzen” but the “business of human impacts and the role of human activities in ecological function and in environmental systems” transcended the term alone (1x interview). In this way the editorial teams at both journals could recognise that their own visions of what the Anthropocene concept could deliver for them might differ from that forwarded by the AWG - the very vision that had driven the concept to prominence - but “it would be crazy... to suddenly change” to another term now (2x interviews).

As a result the editorial board of *The Anthropocene Review* sought to chart a careful route between poles. They were as-yet unconvinced by the rationale for and possibility of stratigraphic formalisation, referring to the AWG somewhat dismissively as “those geologists and their committee” (1x interview). The AWG may have had a particular - albeit limited - authority to consolidate a formal stratigraphic vision of the Anthropocene, but the value of that project of formalisation lay in granting visibility to a more expansive conversation about human impacts.

If by [formalising] they motivate people to take the whole thing seriously then so be it.

(1x interview)

In this sense, formalisation offered a kind of “official cachet”⁷⁰ that made the Anthropocene matter, even if the act itself had limited bearing on the role that the journal was to play. Thus, the editorial board was both happy to defer to the AWG’s expertise by leaving that question “to the stratigraphers,” while at the same time dismissing the impact that non-formalisation could later have for the titling of an Anthropocene-named journal (1x interview). At the same time the editorial board were dismissive of the role of the ESS-driven vision of the Anthropocene that began to establish itself in the later works of the AWG and across the journal as a whole (see Oldfield 2016), noting that it was “quite unrealistic to think of [the Anthropocene] entirely as a scientific modelling idea” (1x interview). Despite giving journal space to relatively uncompromising positions on the appropriate scientific understanding for the Anthropocene - like those voiced by environmental philosopher Clive Hamilton (Hamilton 2015a; 2016a; Hamilton & Grinevald 2015) - the editorial board were concerned not to let debate descend into a series of “noisy” attempts to claim authority over a singular scientific vision of the Anthropocene (1x interview). Instead, the journal could flourish precisely by allowing debate over the Anthropocene concept to expand to accommodate the range of interesting perspectives on offer.

In line with the views of their editors, an idea of ‘inter~’ and ‘transdisciplinarity’ was central to the role of each of these journals. The launch editorial for *Anthropocene* advocated the need for “interdisciplinary collaborations to account for human interactions with earth systems” (Chin et al 2013, p1), *The Anthropocene Review* was justified by the need for “transdisciplinary engagement” with the Anthropocene (Oldfield et al 2013, p1), and *Elementa* prided itself on its desire to be both “multi~ and trans~ disciplinary” (*Elementa* homepage, 2015). Each also wove this multidisciplinary ambition into broader questions about the role of the Anthropocene. *Anthropocene* set out an “overarching goal” and “main focus” in “understanding and predicting how earth will continue to evolve under increasing human interactions” and the importance of such

⁷⁰ This concept of ‘official cachet’ appears to have served an extremely similar function to the ‘technical legitimacy’ that helped to structure the Stockholm Resilience Centre’s communications strategy (see Chapter 4). In both instances, the particular cultural authority of science served as an opening for a series of conversations that quickly expanded beyond the limitations of a purely scientific framing.

research “in maintaining a sustainable earth for future generations” (Chin et al 2013, p2), and *The Anthropocene Review* proposed that “science [could] help lead... global society towards greater awareness of its impacts, and guide it towards responsible, wise use of the resource systems upon which it depends” (Oldfield et al 2013, p2). Adopting the most explicitly normative stance of the three, *Elementa*’s introductory video contrasted bucolic images of wildlife with a voiceover solemnly proclaiming that “humans share this earth with tens of millions of species, and that one species is exerting an overwhelming influence” (ibid). As this challenge would affect us all, the journal pointed to its own open-access and non-profit status to demonstrate their commitment to making their research as widely available as possible (ibid).

Despite setting out to encourage a range of interventions, the editorial board at *The Anthropocene Review* believed that the journal would generate only limited interest in the social sciences and the humanities. To the surprise of the whole editorial board, they found hard scientific papers to be in the minority to papers that dealt with questions as diverse as sustainability (Karlsson 2016), governance (Biermann 2014), geopolitics (Dalby 2015b), and moral hazard (Reynolds 2015). This was a “welcome realisation” which they claimed emerged from the recognition that the problems the Anthropocene was said to represent “depend on human action, human commitment, politics, philosophy, perceptions, [and] media” (1x interview). As a stratigraphic, or even as a more loosely imagined ‘climate concept’, the Anthropocene simply could not generate solutions to the climate problem. However, in viewing the Anthropocene as a normative and motivating concept this “humanistic stuff” became a vital way of thinking about how to engage governments and decision makers and consider how to map out new possibilities for the future (ibid). Recognising how the discourse had evolved in response to the space they had created for it the editorial board eventually appointed an environmental historian to serve as the journal’s chief editor (see Endfield 2015). Taking a depreciating view of the “dirty-booted” empirical expertise the editorial board already possessed, the editorial board recognised the potential for Endfield to navigate the challenge of taking seriously both the science and social dimensions of the Anthropocene discourse (1x interview). Nonetheless, and despite clear enthusiasm for

the work that might be done under the aegis of the concept, the editorial board held no pretences that “words like the Anthropocene [could] impress the people we need to impress” like the public or political leaders (1x interview). As a result, *The Anthropocene Review* - as with *Anthropocene* - had created an interesting space: one neither rooted in any particular disciplinary formation, nor necessarily able to serve as a bridge to more public understanding. Likewise, while *The Anthropocene Review* fostered ‘philosophical’ discussion as part of its ‘transdisciplinary mission’, *Elementa* drew quite different boundaries on what might appropriately be considered a part of the broader Anthropocene discourse. Despite the more public-facing stance implied by their editorial video, the editorial team viewed the vision of inter~ and transdisciplinarity that they were to nurture was more deeply contextualised, relational, and limited. Drawing a pragmatic line around what one journal alone could achieve within such a diverse set of conversations, *Elementa* set its sights on the smaller “subset” of “interdisciplinary science” alone (1x interview). That is, even with the explicitly normative and value-fronted footing of the journal’s mission statement, the editorial team felt wary of engaging too heavily in overtly political discussion that might undermine their intentions towards scientific objectivity. Instead, “scientific credibility” reigned supreme, and it was only upon passing this test that a manuscript could proceed to publication. Thereafter the journal actively sought to avoid setting a clearly politicised “agenda” that would risk appearing too unscientific (ibid). As a result, *Elementa* - together with *The Anthropocene Review* and *Anthropocene* - helped to create a space at once political and not, dependent on stratigraphic formalisation and yet seemingly uninterested in the outcome of that specific discussion, in support of various visions of a multidisciplinary engagement with the Anthropocene, and yet in disagreement about what that should mean in practice.

8.3. Epistemic Friction and the Anthropocene

STS scholar Eileen Crist has noted that as the Anthropocene proliferated through the literatures of various disciplines it became increasingly challenging to discern a difference between what might be called serious engagements, and more “casual deployments” of the term (2015, p14). Both contributed to the sense that the Anthropocene must be responded to, with “compounding uses” only serving to indirectly strengthen the legitimacy of the term and its place in contemporary discourse (p15). Thus, “suddenly “The Anthropocene” [was] everywhere” (Pawson 2015, p306), a ‘Grand Narrative’ that could encapsulate almost any discussion of anthropogenic global change and a free-for-all. The stage was set for increasingly wide-ranging commentaries that considered the Anthropocene - as both metaphor and signifier for a new period of time - in domains as diverse as tourism studies (Gren & Huijbens 2016; 2014), and outer space archaeology (Gorman 2014). Rather than something more sustained, much of this interest resulted in authors producing only a single piece on the Anthropocene. These single interventions covered a range of areas, capturing - for example - the blurring of the modernist ontologies of Nature and Society ‘in the Anthropocene’ (Adams 2016), the morality of geoengineering (Preston 2012), how to re-read artistic representations of the “new materialisms” of the Anthropocene (Helmreich 2015), and how we might undercut anthropocentric thought and ‘hear others’ in response to ecological crisis (Kannigieser 2015). As a result, a challenging boundary began to emerge between arguments that could proclaim direct stakes in the Anthropocene controversy and the ever-broader adoption of the term.

The examples given above might set out obvious states in the Anthropocene controversy and I have no desire to question their scholarly value. Nonetheless, their avowedly non-stratigraphic and non-scientific approach to the concept served to reinforce a sense amongst some interlocutors - whether operating in the earth or environmental sciences or the social sciences - that the Anthropocene had begun to serve as little more than a ‘buzzword’ to support unscrupulous others in boosting their own prospects for publication (1x interview; similarly expressed 1 further interview).

While the accusation that others might deliberately ply the Anthropocene concept in a 'non-scientific' way in search of publications appears to make a statement about the integrity of certain kinds of scholar, it misses the knowing trade-off that others make when they chose to embrace the metaphoric possibilities inherent to the concept. For example, rather than fixate on the specific scientific claim that we had entered the Anthropocene, or appropriate expertise through which we might know that change, a number of interlocutors in the social sciences and the environmental humanities saw value in the concept (and the associated term 'Anthropocene') precisely because it could serve as a "provocation" (1x interview). As one postmodernist scholar noted, irrespective of the scientific controversy and its ultimate resolution, the concept have value precisely because it could serve as a kind of shorthand "for [the] disorienting range of crises and contradictory positions" that they felt to define contemporary ecological crisis (1x interview).

I'm not especially concerned with whether or not we have entered a new geological era from the perspective of that discipline [stratigraphy]. That can take care of itself.

(1x interview)

Like those editors who helped to channel particular discussion of the Anthropocene into a dedicated journal space, these scholars recognised "the inbuilt cachet" of the Anthropocene and sought to make use of a term that was already 'out there' and over which the stratigraphers in the AWG could not claim complete control or "dibs" (ibid). This presents a challenge in terms of discerning the movement of knowledge because incidental and oblique reference to the Anthropocene in work that was otherwise concerned with existing climate change narratives (for example Watts 2015) meant that the Anthropocene was sometimes little more than an exciting new "metonym" for existing terms (Rudiak-Gould 2015). That is, it could serve as a vehicle to reinvigorate existing discourses rather than as the impetus to do something new.

While some - in defending their own particular niche within the broader controversy - might go so far as to describe this broader adoption of the Anthropocene as a kind of “usage” (1x interview), it is difficult and unfair to judge these engagements in terms of their ‘rightness’ or ‘wrongness’, or the appropriateness of their fit to the Anthropocene. Starting with Paul Crutzen’s very first consolidation of his ad-libbed neologism in the pages of the *IGBP Newsletter* (Crutzen and Stoermer 2000) and consistent through almost every intervention into the controversy that Crutzen established, the debate revolved around the dual questions of how best to understand the phenomenon of global change and how to decipher meaning from that change. As one ecologist suggested to me, if the Anthropocene was intended “to awaken natural scientists to the fact that they should probably get out of their individual silos and try to understand coupled human-natural systems in order to understand global change,” then scholars could indeed argue that their own interventions would contribute to that broader effort (1x email). However, despite reasonable justifications, many of these scholars deployed language in a very different way to interlocutors in the earth and environmental sciences. For all the seriousness with which this work considered the implications of Anthropocene science, it was defined by a much looser sense of the specifics of stratigraphic terminology. To take but one example, despite a sustained intellectual engagement with the implications of the concept, geopolitical theorist Simon Dalby referred to the Anthropocene variously as both a geological ‘period’ and an ‘epoch’ (Dalby 2007, p103; 2014b), as well as an ‘era’ (2007, p116), before dropping the qualifier and simply referring to ‘the Anthropocene’ in latter works (Dalby 2015a; 2015b). Far from inconsequential, this small rhetorical shift helped to further divorce the concept of the Anthropocene from any particular disciplinary connotation in Dalby’s writing. That is, where the specifically geoscientific debate revolved around particular disciplinary formations and the role they might play in producing the most reliable definition of the Anthropocene, scholars in this space were more interested in what the concept might ‘do’. Nonetheless, this space produced some confusing engagements with the Anthropocene. Where political theorists Jonas Anshelm and Anders Hansson considered the crisis-based and catastrophist framings of geoengineering advocacy in public discourse, they discussed geoengineering as both the “trigger and (ultimate)

response to the Anthropocene” (2014, p103), making it unclear what function the Anthropocene served in their writing. In the above, the Anthropocene stood for both the discursive space and the object to which geoengineering advocacy was considered in response. A special edition of the journal *Global Environmental Change* dedicated to the Anthropocene mirrored this confusing and conflicted positioning. Within its pages environmental anthropologist Eduardo Brondizio and his co-authors questioned whether it was “a feature of the Anthropocene that the dynamic of the complex system has become independent of the reflection about it?” (2016, p325), and urban scholar Xuemei Bai and co-authors rendered the Anthropocene as a “perspective” that would help us consider the future of the physical phenomenon of “the Anthropocene” (2016, p351).

In a sense, these scholars recognised that all science consists of metaphors, “to be judged, aesthetically as well as intellectually” only in terms of our willingness to accept them as real (Weiner in Springer 2017, p10). Postmodernist writing has regularly been targeted for not adhering to the same (supposed) rules of writing as the natural sciences. Physicist Alan Sokal (1996a; 1996b; 2008; Bricmont & Sokal 2003) famously submitted a ‘hoax’ paper on the “transformative hermeneutics of quantum gravity” as proof of lax academic standards in cultural studies. When his paper was published, Sokal received support from high profile public commentators like Richard Dawkins (1998), and went on to inspire a legion of acolytes who to this day still attempt “Sokal-style hoaxes” in postmodern journals (see Boghossian & Lindsay 2017a; 2017b for a contemporary example). Within this climate, scholars in the humanities and social sciences feel forced to justify their use of ‘esoteric’ jargons (Springer 2017, p14). This is a situation that postmodern scholars might reasonably find unfair. For example, cultural geographer Timothy Cresswell has noted the fundamental cheapness of using ‘jargon’ as pejorative to criticise non-scientific writing given that natural scientists themselves rely on highly specialised jargon and that there can be good reason to be playful with words that are so familiar that they no longer require us to think about their meaning or intended application (2013, p10). Commenting directly on the Anthropocene, geographer Lauren Rickards has baulked at a broader tendency to assume that

“science sits in contradistinction to metaphors” and has pointed to the way in which scientific metaphors simply have a tendency to slip from view (2015, p282). Nonetheless, there was no system in play for scholars in the social sciences and humanities to distinguish between a formal conversation about the physical phenomenon of the Anthropocene and a more informal and metaphorical use of that term. Rather, as one postmodern scholar noted during interview, the Anthropocene was simply there to be “hammered away at and used up” (1x interview).

By contrast interlocutors from the earth and environmental sciences were generally better at clarifying the difference between their (intended) formal and informal use of stratigraphic nomenclature. In making the case for their own prospective lower boundary dates Lewis and Maslin noted that “formal time-unit names have a capital letter: Anthropocene Epoch... [and that as a result] the Anthropocene should not be treated differently” (Lewis & Maslin 2015a, p246). Likewise, in positioning informal visions for the Anthropocene both Ruddiman and Brown were careful to deploy the lower case: “one way forward would be to use the term informally (with a small “a”)” (Ruddiman et al 2015, p39; also Ruddiman 2015), and; “the community must wake up to the debate before they find themselves inside, outside or straddling a new geological era (small E)” (Brown et al 2013, p433). While these latter two comments were clearly written in a sarcastic and jokey tone, the fact that there were rules about formal stratigraphic language - and that these interlocutors were able to demonstrate a greater relative expertise in navigating those rules - gifted them a powerful tool by which to exclude voices that they perceived to engage with the Anthropocene terminology in unclear ways. In so doing earth and environmental scientists could tap into existing cultural differences in the modes of enquiry between the natural and the social sciences (Osborne 2013, p83). In effect they could make themselves look serious, and leave more ambiguous adoptions of the Anthropocene looking ‘parasitical’ (ibid), ungrounded, and non-scientific.

Curious to see how the Anthropocene had spread beyond publishing alone, I contacted an Anthropocene-named research cluster from a UK Russell Group university. This

research group, embedded in an earth sciences department, was named for the Anthropocene and worked on the detection and attribution of climate change as well as understanding past and future climate variability. Their work, generally contemporary in focus, accounted for change from the Industrial Revolution, through to the kind of near-term future projections that help to inform the UN's Intergovernmental Panel on Climate Change. While discussion of the Anthropocene served as an opening to a series of engaging and interesting conversations about science, public engagement, and the challenges presented by climate denialism, the group's engagement with the Anthropocene was less 'active' or 'constructive', and did not serve to shape or influence the trajectory of their research interests or scientific practices (1x interview). As group members made clear, the value of the Anthropocene as a moniker - and their initial justification in adopting the term - lay in appeasing the UK's Research Excellence Framework and the demands it places on researchers to demonstrate contemporary relevance (2x interviews). In this way, their association with the Anthropocene served as little more than a gimmick to "save words" and demonstrate that the group were engaging with developments in their research area (1x interview). Despite this initial impetus to embrace the concept, neither were the group oblivious to implications of the concept or its nominal grounding in stratigraphic practice. By contrast, the group's self-avowedly loose familiarity with the International Chronostratigraphic Chart meant that members were comfortable suggesting that the Anthropocene "seemed an appropriate name" for the group to adopt despite the concept exerting no impact on the shape of their research efforts (ibid). Indeed, group members offered me a wide variety of start dates and definitions for the Anthropocene, some of which were sympathetic to Ruddiman's 'early Anthropocene hypothesis' (1x interview), others roughly corresponding to Crutzen's original proposal in the Industrial Revolution (1x interview), and some in the 1990s that differed dramatically from any position voiced elsewhere in the controversy as it had played out in the literature (1x interview). For other members the Anthropocene had more in common with archaeology than with stratigraphy (1x interview), and while none of the positions offered to me corresponded exactly to either the AWG's position or the profusion of dates offered in the broader controversy, a sense of disciplinary identity meant that members of this research group would not be willing to

move beyond their currently held conceptions (1x interview). Simply put, the versions that they held in their own heads worked for them and even the consolidation of a new GSSP - should the controversy ultimately produce a formal definition - would give them little reason to change (2x interviews).

Despite some concern about dipping their toes into an active controversy (1x interview), members of the group saw conceptual value in the Anthropocene because of the role that it could play in conceptualising the transition from humans as “passive inhabitants of the earth to active manipulators” (1x interview). Thus, for this group the Anthropocene was simultaneously a valuable conceptual framing and little more than a discursive framing. There was communicative value in the concept precisely because it was so vague, and yet the lack of a proper definition made them “reluctant” to use it in their actual research (1x interview). In a familiar pattern, members of the group were dismissive of others engaged in the broader discourse. While ‘the Anthropocene’ might have been a bandwagon used to pepper grant proposals and generate funding “by others” it was “a nice definition” for them (1x interview). By contrast it was those “scholars that [came] in from completely outside that [thought] 'oh we'll use the term Anthropocene, because it's trendy'” that made the concept problematic (ibid).

I think there's some suspicion with the Anthropocene that people are trying to use it to make what they do seem relevant. That's something that as academics I think we should be watchful of. If there's a sense that we're using terms like that just to suit ourselves and get funding, that's one of the arguments the climate sceptics use, that you're using this just to write proposals to one another to get funding. So it's one [thing] we have to be squeaky clean on.

(1x interview)

It might have been that the question of stratigraphic formalisation was the concern of only “a relative few” researchers (1x interview), but the group’s own adoption of the term belied the way in which the Anthropocene was driven to prominence exactly by the very

same willingness to trade on a new and exciting terminology. That is, as with others willing to police a somehow 'improper' looser embrace of the concept, members of this group were likewise able to lean into a series of cultural images of science and its relationship to other disciplines to support their own invocation of the concept.

Thus, despite the group's own ambivalent relationship with the Anthropocene, members derided the "perplexing anguish" of colleagues in the humanities who saw opportunities in the term beyond the "little bit obvious" declaration of profound human impacts on the contemporary environment (1x interview; similarly expressed in 1 further interview). Policing adoption along familiar epistemological lines despite their own avowedly non-scientific motivation to adopt the concept, members were willing to attack 'navel gazing' in the humanities and human geography - a discipline that I was seen to represent - over the use of the Anthropocene (1x interview). Despite recognising the complex nature of disciplinary boundaries, the Anthropocene was seen as a safe label for 'scientists' to deploy, and yet unhelpful for the 'humanities'. Within that space my questioning the role of the Anthropocene was not seen as an opportunity to cross disciplinary lines, but as an invitation to attack the representative of an unwanted discipline. One participant had actually taken the time to print off an article on affect and immanence written by two human geographers - Catherine Leyshon and Hillary Geoghegan (2012) - prior to our interview. Waving the article at me, this participant regaled how the paper was on the coffee table of their department "and someone had written on it 'this is not a spoof paper!'" (1x interview). It was, I was told, full of "crazy language, jargon... drivel," and had squandered the opportunity to do meaningful research (ibid). It was, in short, a "waste of public money" (ibid).

There was a move by this participant to criticise "human geography language" more generally in its myriad applications from the sustainability debate to the Anthropocene (1x interview). Instead of making use of the openings these concepts could provide, human geography was decried as a discipline consumed by endless circular debate about the meanings of words, and defined by its ability to "corrupt" the terminologies it adopted (ibid). While voiced most explicitly here, such views on the proper settlement

between disciplines were echoed throughout this research. Whether by journal editors (1x interview), Quaternary scientists (1x interview), geopolitical theorists (1x interview), or environmental philosophers (1x email), numerous participants made denigratory comments about interventions in the Anthropocene controversy that moved away from a clearly scientific framing (see also Hamilton 2014b). This broad scepticism about the role of critical enquiry into the role, function, and movement of the Anthropocene (the project of this research), bled in some cases into a more trenchant criticism that such an interest in the Anthropocene as a controversy could only emerge from a failure to understand the scientific claims that supported the concept (1x email). Condemning the 2015 Royal Geographical Society - Institute of British Geographers annual conference on the Anthropocene - explicitly promoted on the possibility of the Anthropocene to foster “interdisciplinary debates” across the ‘hard’ and ‘social’ science divide (RGS-IBG 2015) - as a “wasted opportunity” that had robbed the Anthropocene of any meaning, one British Society for Geomorphology Fixed-Term Working Group member stormed out of their own session saying “for fuck’s sake! I’m never coming to the RGS-IBG ever again.” Others engaged in the controversy noted that while the Anthropocene might be in part about ‘hard science’ moving into the domain of the ‘humanistic sciences’, this move carried reciprocal obligations. Thus, where interlocutors in the social sciences and humanities had successfully “understood and articulated” the science of the Anthropocene, they were given praise (1x interview). Elsewhere, however, scientists could be forgiven for not meeting humanities scholars on their terms, because they were “getting their essential scientific work done...[and] getting on with it” (ibid). Drawing on a long career in geography departments riddled with human geographers who had wasted their time on “esoteric and needlessly abstract” problems, one participant noted the importance of the Anthropocene in forcing such scholars to stop indulging in pointless questions, “to get real,” and to recognise the mileage of engaging with problems in the “real world at the present day” (1x interview). Despite front footing a strong criticism, the same participant later seemed aware of the limitations of a purely scientific framing where the question moved beyond the documentation of change and onto the production of a response. That is, while humanities scholars were asked to ‘get real’ and to support the mobilisation of this scientific fact to productive ends, a former

journalist - Gaia Vince - was given praise for her book *Adventures in the Anthropocene* (2014) precisely because it had left behind the science of the Anthropocene in order to engage with questions of human resilience.

8.4. Fractional Coherence and the ‘Dual Career’ of the Anthropocene

Like Crutzen’s original vision of the Anthropocene, the more discursive vision of the Anthropocene that I have traced through this chapter signalled an important relationship to stratigraphy. In this sense, it perpetuated the same epistemic burden to which the AWG was initially established in response. Nonetheless, the passage of time had left the latter adoption of the Anthropocene different from Crutzen’s earlier efforts. By the time this broader conversation had developed to maturity, the AWG had already taken some measure of control over the Anthropocene controversy as a whole. That is to say that while it was not yet definitive - and not yet formalised - the AWG had led the way in developing a wholly credible stratigraphic argument to support the relationship between the Anthropocene and stratigraphy that was initially only implied. As a result, the movements detailed above helped to establish and maintain a peculiar split in the Anthropocene controversy between a formal argument about the International Chronostratigraphic Chart - viewed by some interlocutors as problematic and to be dealt with at arm’s length - and an ‘informal concept’ that could serve everyone else who wanted to put the concept’s popularity to use. In this way, interest in the Anthropocene had helped to construct a “dual career” for the Anthropocene that left it as both a “geological term *and* a cultural term” (KTH 2016, online). Because this dual career had been ‘hardwired’ and stabilised (see Galison 1987) by the creation of dedicated journals, interlocutors like neomarxist theorist Jason Moore were able to make space for their own interventions by quite reasonably claiming that the Anthropocene was “in fact a family of arguments with many variations” (Moore 2016, p2). In this way Moore and others could fold the Anthropocene’s “discontents” - those dimensions of global change knowingly or unknowingly overlooked by the AWG’s vision of the concept - back into the discussion and declare that they too were a part of what the Anthropocene concept was about (Moore 2016, p6; pp 13-76; also Davies 2016).

In this sense, interlocutors still questioned the Anthropocene's value as a scientific object and held different views about what it was 'for', but they appeared to recognise that mutual suspicion, overt hostility and conflict would make "impossible the easy co-operation and trustworthiness that are essential to effective scientific work" in the broadest sense (see Barber 1987, p125). However, if the Anthropocene had indeed become something that might be shared across disciplines, there was very little discussion of how its geological and cultural dimensions would meet. Beyond the odd exception - like a staged dialogue between human geographer Andrew Barry and geologist Mark Maslin (2016) - the challenges of this 'dual life' were rarely articulated. Instead, those engaged with the Anthropocene debate seemed happy to refer to the Anthropocene in terms of its separate formal and informal variants (for example Autin 2016) despite the challenge of disentangling the two in practice. As with members of the AWG who advocated for formalisation because of the statement it could make on human impacts, advocates for formalisation in this broader space wanted the best of both worlds. For example, political scientist Victor Galaz and sustainability scholars Johan Rockström and Laura Pereira all sought to downplay the implications that formalisation might carry for actual scientific practice on the assumption that researchers would know how to navigate the time-transgressive reality of change in any case (Galaz 2015; Rockström 2015; Pereira 2015). Although the authors seem oblivious to it, such a position only raised questions about the need for a formal version of the Anthropocene if researchers were liable to ignore it anyway.

In his dialogue with Barry, Maslin implied that the decision to iterate on the Anthropocene until all were satisfied was simply part of the culture of scientific investigation, "whereby if a theory is shown to be incorrect then a modified or alternative concept or theory is presented" (Maslin in Barry & Maslin 2016, e00022 p4/12). In the interest of encouraging others to "rise to the challenge" of the "pan-disciplinary concept" of the Anthropocene, Maslin argued that the formal debate would produce "only one of many equally valid definitions of the concept" (ibid). Despite the gesture of openness, the tone was nonetheless dismissive of accounts in the social sciences and the

humanities. Rather than accepting that scholars might have reasonable political stakes in the controversy, Maslin instead seemed to reaffirm the epistemic privileging of the natural sciences. For “conversation to occur between subjects” social scientists would need to engage themselves in a “constructive rather than a destructive debate” (ibid). Ignoring the symbolic power of formalisation, Maslin further argued that it was “incumbent on other subjects such as history, politics, anthropology, [and] geography... to have their own definitions of the Anthropocene” (p7/12). This view that scholars ought to go off and “invent their own Anthropocenes” was mirrored during interviews with members of the British Society for Geomorphology Fixed-Term Working Group, even as their own work had pointed to the implications of confusion over multiple meanings and contexts and what this might mean for an ‘invisible’ discipline like their own (1x interview). I am suspicious of the suggestion that encouraging a further proliferation of variants could ever lend greater clarity to the Anthropocene. For one, the controversy was not so simple as a debate between formal and informal variants, nor between the natural sciences on one hand and the social sciences on the other. For example, neomarxist theorist Alf Hornborg was highly critical of other social scientists like STS scholar Bruno Latour (2012; 2013; 2014) and postcolonialist historian Dipesh Chakrabarty (2009; 2012; 2014) for their decisions to adopt the Anthropocene. In these two scholars, Hornborg saw prominent voices in the social sciences publicly disavowing twenty years of research on the “theoretical implications of the interfusion of Nature and Society” in order to claim that the Anthropocene represented something new (2015, p57; 2016; also Bonneuil & Fressoz 2015, p227). In this sense, the ‘pan-disciplinarity’ of the Anthropocene expounded by Mark Maslin not only created space for friction across disciplines over the ways in which they deploy language and to what effect, but also between disciplines that might naturally find themselves in closer alignment over the extent to which they must accept claims that had emerged elsewhere.

Critically, the controversy was also predicated upon interlocutors moving between different guises when making their arguments. Accusing the Anthropocene of having more to do with pop culture than science, stratigraphers Whitney Autin and John Holbrook were highly critical of the controversy and the relationship they felt it had to a

vacuous cycle of credibility (2012a). Questioning the “clever end game” of other interlocutors, they suggested that the Anthropocene did little more than play into the mediator role of societal ‘relevance’ to produce a concept that generated very little in the way of new insight (p61). Drawing on the work of philosopher of science Lauren Hessels, Autin and Holbrook pointed to the Anthropocene as yet another example by which scholars were rewarded “for making beautiful promises about the (possible) relevance of their research” without having to realise those same promises (from Hessels et al 2009, p398). Despite staking out this oppositional perspective, Autin later returned to the controversy to expound the value of the term as a “dynamic tag line” to enhance environmental awareness in the pages of *The Anthropocene Review* (Autin 2016, p218). Despite his suspect endorsement of the Anthropocene, Autin’s latter article - ‘Multiple dichotomies of the Anthropocene’ - was an interesting and engaging pathology of the Anthropocene controversy in which Autin dissected the controversy’s axiomatic splits over the role of formality and informality, the philosophical and political prospects of “good versus dystopian outcomes,” and the roles of differing scientific visions in supporting those agendas (ibid). With some sensitivity to the increasingly fraught tenor of the controversy - to which he had himself contributed - Autin cautioned that while different versions of the Anthropocene might be co-opted in support of different political agendas, “questions posed by scientists about the complexity of human-induced environmental influence need to be viewed as healthy scientific discourse and not a treasonous departure from an irrefutable dogma” (p224). Clearly this complex positionality with regards to a controversy that he had helped co-produce was not without nuance, but neither was Autin alone in navigating it in complex ways. The members of the British Society for Geomorphology Fixed-Term Working Group sought to debunk the Anthropocene for the sake of geomorphology even as one of them served on the editorial board of the journal *Anthropocene* and the group ran special editions within its pages (Tarolli et al 2014). A number of participants in this research who were engaged by the more-than-scientific dimensions of the Anthropocene concept were insecure about the prospect of being seen as “bandwagon jumpers” for embracing the Anthropocene even as we discussed their (undisclosed) agnosticism about the value of the concept (3x interviews). When I pressed an environmental scientist on

whether it sent mixed messages to challenge the AWG's particular vision of the Anthropocene and the broader use of a scientific framing to foment political and normative discussion, while simultaneously using the term in the titles and abstracts of their own work with the explicit intent to solicit views, they acknowledged the problem but responded that if their writing was "overly simplistic... it [had] to be" (1x interview).

Perhaps sensing that the very discourse of interdisciplinarity was 'up-for-grabs' (see Barry et al 2008, p24) in the controversy, those who adopted the Anthropocene appeared to view their work as a kind of necessary bricolage. That this introduced epistemic friction and drew perspectives into conflict was simply a sign of progress. These conversations 'needed' to happen and it was only by having them that scholars could develop better understanding between disciplines and a better understanding of anthropic impacts on the planet (for example Brondizio & Syvitski 2016, p316; Latour 2015; Maslin in Barry & Maslin 2016, e00022 p9/10; Verburg et al 2016). However, as Harry Collins, Richard Evans, and Michael Gorman have noted, there is no meaningful trading zone to be produced between different parties if there is only trade (Collins et al 2010). The interlocutors involved in the Anthropocene discourse might have longed for a shared conversation in the best interests of all, but it may be fair to state that they did not recognise that they understood the object in question quite differently. While Peter Galison is more sympathetic about the production of shared creoles or 'contact languages' and what might be achieved with them - on the grounds that trading partners might "hammer out a local coordination" despite different aims, intentions, and understanding (1997, p783) - the fact that the Anthropocene supported such a wide range of conversations made it a challenge to understand what exactly the Anthropocene itself was for. Far from fixing upon a clear definition, controversy had kept the challenge of defining the Anthropocene in flux, and left it "subject to change with the occasion of [its] use" (Woolgar 1988, p33; also Knorr Cetina, p175; Rheinberger 1997, p36). In this sense, sharing the term Anthropocene alone did little to illustrate how different epistemic traditions might be made to work together productively.

As one physical geographer noted during interview, if the above represented a thing called interdisciplinarity, then it was a version of interdisciplinarity that missed out on “the people who are already talking to each other but not necessarily [in such a] high profile [way]” (1x interview). Instead of finding a productive way to actually converse across disciplinary divides, the Anthropocene had become a way to demonstrate a commitment to ‘interdisciplinarity’ without requiring anything new from those who adopted it. In effect, interlocutors had forgotten that the practice of interdisciplinarity was more important than its discursive deployment (Weingart & Stehr 2000, pxiii). Worse still, the loose consensus that allowed the Anthropocene to be everything for everyone had created its own powerful discourse. Sensing that the broadly shared ‘agreement to agree’ with the Anthropocene had produced its own particular kind of pressure, I note the effort of the members of the Holocene Working Group of the ICS to make clear that their objections to the prospect of stratigraphic formalisation of the Anthropocene did not equate to a disavowal of the evidence for anthropogenic global change itself.

Our concern is to centre the debate not on whether people are driving climate and environmental change but rather on the proposal that these changes register sufficiently strongly and unequivocally in the earth's stratigraphic record to warrant the recognition of a new unit in the [International Chronostratigraphic Chart].

(Walker, Gibbard & Lowe 2015, p3)

In making clear their recognition of anthropogenic change (also Gibbard & Walker 2014, p29) the members of the Holocene Working Group attempted to counter the way in which the Anthropocene had become synecdochic for a range of concerns that moved far beyond their understanding of the role and function of stratigraphic investigation. Instead of resigning themselves to work with the term in some informal capacity, there was simply a sense of frustration. One member was keen to stress that “we are not in any way climate-change deniers! Quite the contrary, we are as concerned as anyone about the increasingly detrimental effects of human activity on the earth-atmosphere system” (1x email). In voicing questions about the utility of a stratigraphic Anthropocene

another Holocene Working Group member seemed apologetic, asking “if we can’t be honest, what can we be?” (1x interview). That individuals felt they were being judged based on their commitment to a concept that was not supposed to be political meant that a more fundamental backlash against the expansion of the Anthropocene discourse remained invisible in print (c.f. Rull 2016). Given his unwillingness to sustain his intervention, James Scourse’s wholesale rejection of the Anthropocene as a debate space was simply reabsorbed by other interlocutors as another “fascinating provocation” (1x interview), rather than a more complete objection to the expenditure of any intellectual resource on something Scourse viewed as “nonsense” (Scourse 2016, online). For others, it was the febrile tone of the controversy itself that turned them away. One palaeoclimatologist with objections to formalisation of the Anthropocene declined interview on the grounds that they had simply “grown tired of discussing the Anthropocene” (1x email). In this sense, the Anthropocene was driven to prominence in part because those in favour of this looser discursive vision of the concept had installed itself as a new hegemony. Those who objected withdrew from the controversy, not because they ‘saw the light’, but because they no longer saw a benefit in sustaining their objections (see Kuhn 1996, p151).

None of this is to imply that conflict over meanings and outcomes is not a part of the ‘normal’ scientific process. Peter Galison and David Stump argue that the very “disunified, heterogeneous assemblage of the subcultures of science is precisely [that which] structures its strength and coherence” (1996, p13), a view that is shared by other commentators who see conflict as a fundamental and democratic virtue of scientific knowledge production (for example Mason 2010; Woodhouse et al 2002; Owens 2000). That said, simply racing ahead to create an interdisciplinary space on the grounds of pooling resources and sharing insight had ignored the social realities that govern and constrain the interactions of different groups (see Riesch 2014, p37). Rightly or wrongly, the stratigraphic Anthropocene relied on the specificity of language to denote a scientific concept, while the positions outlined above variously relied upon the flexibility of the concept as a framing or as a metaphor. As a result, crossdisciplinary interactions over the Anthropocene were doomed to be mediated by ‘the anarchy of linguistic differences’

(Oakeshott in Gieryn 1983, p782) by which the terminology of the Anthropocene served markedly different purposes and held vastly different functions for the different communities engaged in the controversy.

The result of all this wrangling was an indeterminate and hazy vision of the Anthropocene. Rather than an 'integrative-synthesis' of disciplines or an 'agonistic-antagonistic' meeting that would cause all involved to reconsider their position (Barry, Born & Wieszkalnys 2008), interlocutors in the controversy had instead produced something that might be better described as an 'interdiscursive' object (see Huggan 2008). This vision of the Anthropocene was built upon the spectre of a shared conversation but not subject to the logic of any particular discipline, and with no obvious rules for its use to be shared across disciplines. Despite vast differences in perspective, this hazy vision of the Anthropocene appeared to hold together as a sort of 'fractionally coherent' object (see Law 2002, p8; also Turner 2000, p55) that could contain multiple overlapping frames of reference and somehow keep shape despite its contradictions. As a fractionally coherent object the Anthropocene had no clear centre and instead only made sense in its multiplicity (ibid; see also Mol 1999; 2002a; 2002b; Mol & Law 2002; Law 2000). Describing this fractiousness as a virtue, anthropologists Heather Anne Swanson, Nils Bubandt, and Anna Tsing called Anthropocene scholarship "inchoate" but not "formless", "without enough materialization to constitute a one, and still too amorphous to be numerable at all" (Swanson et al 2015, p151). If this multiplicity left the Anthropocene without a concrete anchor, it was only evidence of an "inability to capture the reality of the Anthropocene" (ibid). But without something more tangible, consensus around the usefulness of the Anthropocene was instead built on what one geopolitical theorist repeatedly referred to during interview as "the beating heart of the Anthropocene" (1x interview): that is, the simple fact that humans had a profound impact on the earth. Unknowable to any particular discipline, this beating heart possessed a kind of 'obviousness' subject to the rhetorical power of the notions of 'truth', and 'rationality' to derive its stability (Collins 1981). As a result, the Anthropocene had ended up both everywhere and "nowhere in particular" (see Gieryn 2002, p113; Ezrahi 2004, p262).

8.5. Conclusion

Across this chapter I have explored the lock in of the Anthropocene as a discursive space and the implications of that lock in for the controversy as a whole. Responding to growing interest in the Anthropocene, scholars had increasingly recognised the value of the Anthropocene as a site through which they might mobilise their own expertise regarding anthropogenic global change. While it would be improper to judge these engagements in terms of the 'rightness' of 'wrongness' of their fit to the Anthropocene, they had stretched the parameters of the concept beyond the geoscientific framing previously established by the efforts of the AWG in particular. Responding in turn to this widening adoption of the Anthropocene, the period between 2013 and 2015 saw the formation of three dedicated Anthropocene journals. Each reflected this broad interest in the Anthropocene, setting the concept's value in its capacity to foster 'inter~' and 'transdisciplinary' dialogue and eschewing a narrower conversation about stratigraphic formalisation. In so doing they each gave this looser vision of the concept a material presence (Schaffer 2013; Taylor 1996; Galison 1987) that it had previously lacked. Despite the support of journals in touting the interdisciplinary credentials of the Anthropocene, I suggest that shared use of the concept alone did little to foster work across or between disciplines. Instead, different understandings of the use of language and the role of metaphor presented a continued barrier to more integrative efforts. While earth and environmental scientists might themselves recognise that the Anthropocene served them as a communicative metaphor more than a scientific 'fact', they had access to a powerful language of science that could help exert authority and influence in the discourse (Osborne 2013; Oakeshott in Gieryn 1983). However, underneath this language barrier there remained more fundamental trust issues between natural scientists used to 'getting on with it' and social scientists they saw as abusing scientific concepts. As a result the Anthropocene had developed into something quite different to the vision held by the AWG or Crutzen before them. Rather than move the Anthropocene towards factual status, ongoing debate served to stabilise the concept in its most abstract form as a far looser and vaguer 'discursive thing', subject to no

particular discipline and open to all. The decision to hold the concept open in this fractionally coherent way (Law 2002) was no ones to make. Instead, it appears to have come about for two reasons. Firstly, that interlocutors stood to benefit from the interdisciplinarity of the concept without having to establish exactly what that would mean in practice. And secondly, that this agreement to agree that the Anthropocene concept did indeed have significant value meant that there was less pressure to define precisely what the concept should mean or its exact relationship to any particular form of epistemic authority (Collins 1981; Gieryn 2002; Ezrahi 2004). Instead, the Anthropocene - at first defined by its relationship to the particular authority that stratigraphy alone could endow - was here defined by the very non-specificity of its epistemic status and by the lack of clear boundaries on what should variously constitute an internal or external part of the discourse. In the following chapter I continue to explore the implications of the Anthropocene controversy by considering how interlocutors sought to make use of increasingly public forums in making their arguments, and I consider the efforts of the AWG in response to a controversy that had rapidly outgrown their own control.

Chapter 9: Media Interest, Semi-Public Debate, and Boundary Work

9.1. Introduction

Over the course of this thesis I have explored how the Anthropocene went from an ad-lib to an epistemic burden for the discipline of stratigraphy. I traced how the AWG responded to that burden through the accumulation of wide-ranging multidisciplinary expertise and the implications this had on their investigation. And, I explored how the AWG's efforts prompted a response from an even broader range of disciplinary voices that were not themselves represented within the AWG. In the previous chapter I explored how diverse interest had transmuted the Anthropocene into a pair of endlessly fractured classes - one a (nominally) stratigraphic and scientific concept, the other an 'informal' cultural concept - and I considered how the commitment to share the Anthropocene across different disciplines masked fundamental tensions. In this final empirical chapter I trace the expansion of the Anthropocene beyond the spaces of formal scholarly debate. I pay particular attention to the role that the media played as a tool for the AWG to spread their message and build their case for the Anthropocene and the implications that this had for the controversy. Whatever the group's intention, their decision to court public attention helped push debate into an increasingly fraught public space that had material consequences for the group's practice and drew increased scrutiny from the International Commission on Stratigraphy. This additional scrutiny led to the adoption of a number of rhetorical demarcations (Taylor 1996; Gieryn 1983) by the group to protect their vision of the Anthropocene and the prospect that it could achieve formalisation. Despite a retreat of sorts after having lost control of the controversy, I consider the 'paradox of openness and closure' (Callon 2001) inherent in the AWG's on-going arguments. Recognising that they would have to jettison consideration of the politics of the Anthropocene in response to this scrutiny, the group nonetheless understood those politics to derive from the reality of the phenomenon itself. Despite the efforts of members to distinguish between their individual perspectives and those of the group as a whole, and despite their efforts to deny their

responsibility for broader discussion of the concept, members maintained a role for politics in their own thinking. Further, in spite of the group's efforts to better present their arguments such that they might ultimately achieve stratigraphic formalisation, the AWG maintained that they had created something new and fundamentally different for stratigraphy. Drawing on the language of a 'paradigm shift', the group again sought recourse to the reality of the phenomenon. As a result, questions regarding the epistemic nature of the concept were likewise understood to derive from the material phenomenon of the Anthropocene itself.

9.2. The Role of the Media and Semi-Public Debate

Late August of 2016 saw the release of a slew of headlines concerning the Anthropocene in mainstream UK media outlets like *The Telegraph* (Bodkin 2016), *The Guardian* (Carrington 2016; Rees 2016), *The Independent* (Johnston 2016a; 2016b), and the *BBC* (Amos 2016).⁷¹ While the full articles that chased these headlines generally explained the as-yet-provisional nature of the Anthropocene as a geological epoch, the headlines themselves were bombastic in their declaration that the 'experts' had decided that the earth had entered its "first new geological epoch in more than 11,500 years" (Bodkin 2016, online). The release of these headlines coincided with the AWG's presentation at the 35th International Geological Congress (IGC), the four yearly gathering of the International Union of the Geological Sciences under whom the International Commission on Stratigraphy operates. Immediately prior to this event, the AWG had organised an internal vote on the stratigraphic reality of the Anthropocene. Chasing this vote with a press release (University of Leicester 2016c) - a by now familiar pattern for the group in response to major publications (University of Leicester 2016a; 2016b; 2017) - the AWG had actively sought to announce their thinking as widely as possible. Their press release had formed the basis of the headlines above, and while the group's announcement did nothing more than consolidate their collective belief in the argument for stratigraphic formalisation, it gave license to the media to interpret those findings as they saw fit. In bringing the story to print, the media ultimately

⁷¹ Alongside further articles in *Science Magazine* (Voosen 2016), and *TIME* (Gajanan 2016).

mirrored the geological and cultural dual life explored in the previous chapter. For example, despite brief allusions to emotional cues like “optimism,” the first of the two articles published by *The Guardian* was largely predicated on stratigraphic expertise and the “irreversibility” of the changes underway (Carrington 2016, online). AWG chair Jan Zalasiewicz was quoted as suggesting that the term might be formalised within three years, a move that acknowledged that the Anthropocene was not yet ratified while simultaneously implying a momentum and inevitability to that outcome. The second, however, explored questions of urbanisation, rocketry, technological change and the prospect of cybernetic immortality to ask whether we should be optimistic or anxious about ‘our’ collective future (Rees 2016, online). Reflecting the kinds of questions prompted by Crutzen’s earliest interventions in the Anthropocene controversy, this second article dropped the explicitly stratigraphic grounding of the first and suggested that human recognition of the Anthropocene “could lead to even more marvellous eras of evolution” (ibid).

Unsurprisingly, the simultaneous release of the AWG’s internal vote and this explosion of media interest provoked responses from various scholarly interlocutors in the controversy including Noel Castree (2016a), Johannes Lundershausen (2016), and Ben van der Pluijm (2016) who all raised issues with the movement of the controversy into this new and more public space. One of the AWG’s contingent at the IGC recalled being swamped with “very terse” emails from other congress attendees in the aftermath of this flurry of press attention (1x interview). The group’s presentations at that event had explicitly avoided making a proposal for formal ratification (Zalasiewicz et al 2017b) and had instead focused on updating the geological community of their investigations, the case they had built to date, and on discussing methodological issues related to the identification of a suitable GSSP (1x email). That the group were also willing to present on an earlier Anthropocene option based on lead smelting signatures from 3000 BP - an option that ran in contrast to the group’s ‘Great Acceleration’ consensus - had perhaps given attendees a sense that the AWG was still open to debate and challenge. Seeing these headlines those same attendees had been given the impression that the AWG

were playing the field by being conciliatory and deliberative with the geological community, and forthright and direct with the media (1x interview).

Despite demonstrating the role that the media could play in exacerbating tensions, this event was not the first point at which the media were engaged in the controversy. The periodical *Nature* ran an editorial called 'Welcome to the Anthropocene' back in 2003 (*Nature* 2003) when the controversy was still very much in its infancy. Lamenting that (European) summer's particularly hot weather, 'Welcome to the Anthropocene' noted the limited experience of climate change during recorded human history. In arguing for better strategies to mitigate the impacts of climate change, that article acknowledged that the earth was entering "a period that climate researchers have dubbed the 'Anthropocene'" (ibid). While cautioning against the temptation to use one summer's heat wave to sell climate change to a sceptical public, the article noted - somewhat presciently - that "researchers must not overshoot the mark in their public statements" (ibid). As the Anthropocene controversy expanded, so too did media interest. The AWG's first major consolidated work on the Anthropocene in a special publication of *Philosophical Transactions of the Royal Society* in 2011 (as Zalasiewicz et al 2011) saw editorials in the bridge periodicals *National Geographic* (Kolbert 2011), *Science* (Vince 2011), and *The Economist* (as *The Economist* 2011), and prompted a second belated editorial in *Nature* (as *Nature* 2013). The 2014 release of the AWG's special publication of the Geological Society of London (Waters et al 2014a) saw a similar uptick in interest, which on this occasion extended to mainstream news articles in *The Guardian* (Sample 2014) and *The Independent* (Johnston 2014).

Neither does media interest in itself explain why interlocutors in the controversy were so riled up in response to the AWG's announcements in late 2016. Despite persistent media interest - not to mention consistent excitement within scholarly communities - the Anthropocene had not taken root in popular or lay culture. Castree himself had preached caution about overstating the cultural importance of the Anthropocene (2014a), noting that "only time [would] tell if the term becomes a 'keyword' in Raymond Williams' famous sense" (p436) or whether it would fail to transcend its current

'buzzwordy' adolescence and ultimately fade away (p446). Despite the involvement of Johan Rockström and substantial discussion of the Anthropocene's "collateral concept" (Castree 2017b, p6) of 'planetary boundaries', opportunities like National Geographic's free-to-air documentary *Before the Flood* passed without an attempt to push the Anthropocene into more explicitly public discourse. Despite gaining a place in the *Oxford Dictionary* and the odd esoteric reference in *The Guardian* to *Top Gear* entering its 'Anthropocene era' with the firing of Jeremy Clarkson (Williams 2016), the term Anthropocene was not yet in the popular lexicon even if the controversy itself was gaining some recognition (see also Romm 2014, online). Instead, even as the public itself was absent from debate, increasingly public spaces had become essential meeting points for interlocutors to engage with one another over the downstream implications of the concept.

For the AWG and its members, these spaces had long served as a tool for promoting their thinking and a way to garner additional insight on the question of the Anthropocene itself. As one member noted, publications and media interaction were part of a deliberate attempt to "try and get [ideas] out to the [scientific] community and... give an idea of what kind of support there was" (2x interviews). This interest made the Anthropocene visible to "a broader audience of scientists who [might] ultimately bring their ideas to their table" (1x interview). In this sense, the AWG and its members saw their engagement with the media as a part of the scientific process. It was a way for the group to build and stress test their thinking and findings with a broader community of scientists and could serve as a way to garner insight into the broader utility of the concept (1x interview). With this in mind, members sought to take advantage of opportunities to speak publically, level questions, and seek response. For example, both Andrew Revkin and Erle Ellis took to the pages of *The New York Times* in 2011 to promote their own particular takes on the Anthropocene and its implications (as Revkin 2011 and Marris et al 2011 respectively). Colin Waters (& Amos 2016), Ian Fairchild (2016) and Jan Zalasiewicz (& Al-Khalili 2017) similarly used popular interest in the Anthropocene to discuss the topic on the *BBC*. Attuned to the risk that "science left uncommunicated is the proverbial tree falling in the forest with no one to hear," non-

specialist members of the AWG also helped to nuance the phrasing of scholarly articles to ensure their readability for non-stratigraphic audiences (1x survey; 1x interview; see also Figure 9). One member cited the addition of plastics expert Juliana Ivar do Sul to the AWG after palaeolimnologist Neil Rose (2015) and environmental scientist Frank Oldfield (2015) complained about an AWG paper that made inaccurate claims about fly ash (as Zalasiewicz et al 2014b). As the group stressed in a retrospective on the controversy in 2017, their mature response to critical backlash through the incorporation of appropriate expertise served to demonstrate the way in which “critical commentary [had helped] to guide the research activities of the AWG” (Zalasiewicz et al 2017, p17).⁷² Recognising that the existing divisions of the International Chronostratigraphic Chart had come about as a result of often times fraught and protracted debate (Zalasiewicz et al 2010a, p2229), the group found themselves as the central driving force of a similarly tense debate. Nonetheless, they were able to leverage that broader interest in the Anthropocene as a way to counter the limitations of their own expertise, “find out what’s important and try to involve the representatives of [those kinds] of science” (2x interviews).

But the AWG’s more public facing efforts were not just about growing the science; it was also about generating interest and excitement. Grave and weighty public utterances by AWG members like “geologists do not tinker with the geologic time scale lightly” (McNeill in Carey 2016, p3908) served highly symbolic roles. Whether intended to carry such an effect, in such a statement the supposed intransigence of the discipline of stratigraphy to the prospect of human dominance of the earth system was leveraged to dramatise contemporary climate change and the AWG’s nominally stratigraphic response. When the AWG made the decision to publish in the *Bulletin of Atomic Scientists* with their famous ‘Doomsday Clock’ (Waters et al 2015), the group likewise sent a message about the severity of their claims and the narrative eschatology of the

⁷² Members likewise pointed to the rejection of the group’s attempts to formalise the Anthropocene on the basis of a numerical GSSA (Zalasiewicz et al 2012b; 2015a; and Finney 2014; Lewis & Maslin 2015c) as an example of the way that the group responded to negative reactions from the community. In this case, the group transmuted a negative reaction into the justification to pursue a GSSP, “a slower process” (1x interview), but one that might ultimately yield a greater insight into the nature of the phenomenon of the Anthropocene (1x interview).

Anthropocene. The stated intention of that article was to solicit expert help in making sense of the kind of radioactive deposits that could help establish an Anthropocene GSSP (p55), yet the group was nonetheless aware of the symbolism of tethering the Anthropocene concept to the countdown to global annihilation. Accordingly, some members privately questioned whether they should base the lower boundary on radioactive fallout lest it give off the “negative” impression that the Anthropocene was a warning about nuclear Armageddon (1x interview). When the BBC interviewed AWG member Ian Fairchild he spoke of “destiny” and described the Anthropocene as an “era when humanity has to think of itself as a united force that has to look after the earth” (2016). Elsewhere, Jan Zalasiewicz shared the stage with journalist Christian Schwägerl to discuss the “innovations, fears and promise of a pivotal moment in planetary history” at a public discussion hosted by the Royal Institute (Zalasiewicz & Schwägerl 2015). As one member noted, media interest helped to create “a feeling of consequence that engages people” (1x interview).



Figure 9: An image of North America covered in the cumulative global anthropogenic production to date of aluminium and expressed as standard-thickness kitchen foil from

Zalasiewicz et al (2014a, p114). Images like this appear to have been designed to simplify complex stratigraphic arguments for a non-specialist readership.

The AWG may have wished to countenance a plurality of opinions on the Anthropocene, but their efforts had the effect of pushing the controversy into an increasingly public space. Recognising that there was much to debate, the leadership noted that they “arranged to write, in some cases, opposing papers, side by side in the same journal, with the agreement of everybody, and discussed over a glass of wine at lunch” (1x interview). Despite himself contributing to the mainstreaming of the Anthropocene by collaborating with the AWG on special editions (Finney 2014; Waters et al 2014a), ICS chair Stan Finney began to see the commitment to engage the broadest possible readership as evidence that the AWG was more interested in “having fun and getting published” than in preparing a proposal for stratigraphic assessment (in Carey 2016, p3908). In Finney’s view the AWG had mixed up the conceptualisation and documentation of their thinking, with a more blatant process of popularisation (see Lievrouw 1990, p6) that should have come later. The group’s clear desire to be reflexive, open, transparent and communicable (3x interviews) had in practice opened up another line of criticism. As members sympathetic to Finney’s concern noted, “[it’s] not supposed to be about public opinion... and politics, it’s supposed to be about the science” (1x interview; similarly expressed in 1 further interview).

James McAllister has noted that with the cold fusion controversy interlocutors eventually adjusted their norms to bring the public dynamics of the controversy to heel. By bringing the Anthropocene ‘in house’ through the creation of dedicated journals, interlocutors sought to remove the grounds for arguments over disciplinary self-interest by making the Anthropocene serve as a kind of shared object. Without self-interest, and without the conflict that would result from a clash of interests, there ought to have been less of a vibrant controversy to sustain media interest (see McAllister 1992, p44; also Castree 2013; Lewenstein 1992; 1990). However, if the AWG had a clear sense of what they wished to achieve with their attempts to foster a more public debate, the controversy expanded to meet them. This more expansive canvas of blogs, mainstream media, and

other creative engagements complicated the way that interlocutors engaged with one another's arguments. For example, Simon Lewis and Mark Maslin complained in *The Anthropocene Review* that their own arguments regarding the 'Orbis' and 'bomb' spikes were glibly dismissed after a lengthy 10 month peer review at *Nature* - and involving at least one (unnamed) member of the AWG on the review team - by the AWG writing as a collective body in two rapidly released commentaries (Zalasiewicz et al 2015b; 2015c). Part of Lewis and Maslin's objection related to the simultaneous publication in the journal *Quaternary International* of the AWG's first peer reviewed paper to have been published as 'the AWG' (Zalasiewicz et al 2015a). That paper - which advocated a GSSA instead of a GSSP lower boundary - suggested to Lewis and Maslin that the AWG's arguments had become an ideological pursuit of formalisation at any cost. More importantly, Lewis and Maslin complained that despite their effort to go through the formal channels of scholarly debate the AWG chose to publish two rebuttals, one in the "non-peer reviewed correspondence section of *Nature*" and a second in the 'Perspectives and Controversies' section of *The Anthropocene Review*, which "likewise avoided formal peer review" (Lewis & Maslin 2015b, p129). That the AWG also forwarded their arguments in a more publicly accessible format on *The Conversation* (Zalasiewicz & Williams 2015) - an online-only news website that operates under the tagline 'academic rigour, journalistic flair' - only complicated matters further. Lewis and Maslin's objection seemingly related as much to the AWG's by-passing of peer review as to the fact the AWG's arguments - coming in from 'on high' - risked being taken more seriously than their own (2015b). In this more public space absent the vouchsafe of peer review, Lewis and Maslin intuited a danger that the AWG's position would be seen as the singularly authoritative view of the experts.

Lewis and Maslin's concern about the diminished role of peer review was not unfounded. Participants from across the controversy pointed me to James Scourse's argument against Anthropocene "nonsense" (2016) - similarly published on *The Conversation* - as a touchstone in the controversy despite it also having by-passed the slow mediation of peer review (3x interviews). Critically, Scourse and the AWG were not alone in their attempts to resolve the controversy outside of formal channels. Noel

Castree (2016a), Robyn Eckersley (2015), and Mark Maslin himself (2016) also published on *The Conversation* during the course of the controversy. Interventions over the inappropriate etymology of ‘Anthropocene’ voiced by Executive Director of the US non-profit Center for Biological Diversity Kiernyn Suckling at The University of Vermont’s *Immanence* blog (Suckling 2014) elicited a direct response from AWG members Jan Zalasiewicz and Tony Barnosky on the site’s comments section, drew criticism on environmental philosopher Clive Hamilton’s homepage (2014b), and warranted discussion in Bonneuil and Fressoz’s seminal *The Shock of the Anthropocene* (2016). Making use of online news sites and his personal website, environmental philosopher Clive Hamilton attacked the AWG’s Erle Ellis, Andrew Revkin and other adherents of the ‘good Anthropocene’ and ecomodernism (2014a; 2014b; 2014c) with sufficient fervour to warrant the attention of AWG members (1x interview), while Ellis himself regularly voiced his own view on the Anthropocene online through portals as diverse as open-source wiki *Encyclopedia of Earth* (2013a), think-tank *The Breakthrough Institute* (2012; 2013b; 2016) and *The New York Times* (Marris et al 2011). Whether on institutional blogs (Crutzen & Schwägerl 2011; Galaz 2013; Pereira 2015; Rockström 2015; Stirling 2015a; 2015b), in mainstream newspapers (Leach 2013; Revkin 2011; 2014b; 2015), on websites and online newsrooms (Allenby 2016; Edwards 2015; Farrier 2016; 2017; Luokkanen et al 2013; Purdy 2015a; 2015b; Smil 2015; Johnson 2014), or through *TED* talks (Revkin 2014a; Rockström 2010), these informal and non-peer reviewed spaces had become an essential component of the Anthropocene controversy. As discussed in Chapter 7, it was the very fact that radio hosts had started to talk about the Anthropocene that motivated the British Society for Geomorphology Fixed-Term Working Group on the Anthropocene to actively engage with the controversy (1x interview).

During interview a member of the editorial board at *Elementa* expressed their frustration with the provisionality of language that had become increasingly common in politicised discussion of scientific findings in general and the need to refer to a “climate debate” in particular (1x interview; see also Schneider 2009). Recognising this frustration, Sheila Jasanoff has noted that after years doing disservice to the scientific consensus by

pretending the 'facts' were up for debate, the very sense of 'realness' and finality provided by the Anthropocene perhaps helped to explain both the allure of the concept across a range of disciplines and the desire to communicate that to the public (2013, p110). Accordingly, if the Anthropocene could allow scholars to express to those members of the public that did not believe that humans could have the same kinds of impact as a hurricane - or help to "convince the remaining doubters" as science correspondent Ian Johnston suggested in *The Independent* (Johnston 2016a) - that "[could] only be a positive thing" (1x interview). *Elementa* might have placed great currency in being open-access (ibid), but for the most part it was arguments made in non-academic spaces that were accessible to the public and not hidden behind paywalls and academic subscription models. As Bruce Lewenstein notes of the cold fusion controversy, the media might not always be successful in convincing the public of what to believe, but it could have a remarkable impact in terms of telling people what to think about (1992). Outwith reference to the Anthropocene controversy itself or his own writings on *The Conversation*, Castree has noted that the media is "still the route along which the representations of other epistemic communities must travel if they are to capture public attention" (2013, p242). That the AWG were willing to drive these efforts meant that others had no choice but to respond. As a result, it was through these less formal spaces that participants in this research from across the range of disciplines engaged by the controversy felt they could demonstrate their commitment to public accountability over the controversy (2x interviews). In effect, there was simply so much interest in ensuring that the public understood the concept and its implications that interlocutors transported the claims-making and claims-adjudication apparatus of the controversy (see Gieryn 1999, p187) beyond an exclusively scholarly sphere.

While responding to an increasing pressure for researchers to mediate on findings in the name of societal relevance (Nowotny 2006; Nowotny et al 2001; Meyer 2010), this movement also changed the nature of the controversy. In jettisoning the peer review process, these spaces lent a rapidity to the debate that could not be replicated through more formal channels. In common with the cold fusion controversy, the speed of turnover compounded debate making it challenging to maintain a coherent chronology

to any particular line of argument, and generated an instability that only encouraged increasingly strongly worded interventions and exacerbated the space for controversy (see Taylor 1996; Lewenstein 1992; 1995a; 1995b). Earlier in the controversy both Finney (2014), and Gibbard and Walker (2014) had expressed concerns with the AWG's process in their respective contributions to the AWG's Geological Society of London Special Publication, but had offered largely constructive criticisms in the spirit of scientific discussion (Finney 2015). Within a single year Walker and Gibbard (Walker, Gibbard & Lowe 2015) were notably more contrarian in stating their view that there was "no practical value" and "no sound basis" for the Anthropocene (p204), and Finney's arguments had taken on their own combative tone (Finney & Edwards 2016; Finney in Carey 2016). By the time the controversy had spread to the web, provocative words like "delusion" (Hamilton 2014a) and "nonsense" (Scourse 2016) had become common. As one member of the AWG noted, "this [was] not an armchair conversation... I think there's potential for people to yell at each other about this" (1x interview). If the concerns of interlocutors had been to raise questions about the kinds of authoritative voices at play in the controversy and the appropriate way to broach the topic with the public, they were guilty of generating further excitement and further interest, exacerbating the very controversy that they had wished to control. As a result, they had responded to the mainstreaming of the AWG's arguments - and the risk that this posed in terms of generating undue interest in a controversy that was not yet settled - by themselves engaging in increasingly public debate.

The movement of the controversy into this more public space made it increasingly difficult to distinguish between the scientific, technical, and public 'spheres' of the Anthropocene discourse (Taylor 1996, p130). For example, the predominantly white, male, and Anglophonic composition of the AWG became a point of contention only once the group started to combine publications with more public engagement. When the AWG had their first physical meeting between the 1st and 3rd of October 2014 it took place at Berlin's Haus der Kulturen der Welt (HKW), a federally funded public exhibition space in Germany. The AWG's meeting became the centrepiece for the opening of HKW's on-going Anthropocene Curriculum, and the group's private meeting was paired

with a series of more public talks and seminars that were later made available on YouTube. With public exposure, however, the AWG's composition became problematic for the organisers. After all, only one of the group's three female members at that time had elected to travel to Berlin. As one of the organisers of this event explained, HKW was "a cultural institution that is always confronted with a responsibility in these circumstances" (1x interview). As a result, the organisers felt an obligation to offset AWG members by pairing them with philosophers and artists as a way to both enliven discussion and promote greater gender representation on stage. It was this event that brought Naomi Oreskes into the orbit of the AWG. A few days later Kate Raworth - a research associate at Oxford University - chastised the AWG's lack of female representation on Twitter. Chasing her tweet with a commentary in *The Guardian*, Raworth argued that "the Anthropocene is bad enough... spare us a Manthropocene" (Raworth 2014). Andrew Revkin later credited this tweet with spurring the group to include greater female representation (2016, p75). Not only were these more public spaces rebounding on the scientific and technical efforts of the AWG, they also illustrated how open to social influence the group was (Taylor 1996, p179; also Lewenstein 1995b, p408). Try as the group might to illustrate that their arguments were only scientific, in truth they were not immune from the social life they would need to exclude from their final analysis

9.3. Boundary Work and Retreat

While those members of the AWG who also served roles within the broader structures of the SQS were willing to dismiss Finney's criticism that the AWG was having too much fun getting published (1x interview), they nonetheless recognised his concerns. As one such member remarked, by late 2016 they knew that they had "lost control of [the] term, if [they] ever had it" (1x interview). AWG members might not have been able to predict the level of excitement or interest that their public utterances on the Anthropocene would generate (2x interviews), but those with greater institutional experience in the group recognised that the group had nonetheless been "overzealous" in their communications with the media (1x survey; 1x interview). One member suggested that

the risk here was that in going public with the Anthropocene at such an early stage, the AWG had inadvertently presented the SQS with the risk of a “fait accompli” by which voting members would feel obliged to kowtow to a popular demand for the Anthropocene because of the volume of public materials that already existed in favour of formalisation (1x interview). Because these members had experience with other working groups within the ICS they were able to draw a contrast between the exhaustive output of the AWG, and their own far quieter efforts (1x interview). Pursuing their practice as a more traditional “back room” science with limited exposure (1x interview; see also Lievrouw 1990), those working groups were able to take the time to build their case. They would meet, perform field excursions, “look at sections... collect fossils, or whatever... to determine the dates of the boundaries, [then] go and look at different candidate sections around the world” (1x interview). That those working groups were generally tasked with identifying an ideal stratotype for divisions that were already well understood meant there was little space for excitement. In effect, these working groups generally served to consolidate rather than initiate investigations, with the focus on global correlation and the extensive cooperation this required helping to maintain a slow and deliberative process (1x interview).

As private citizens individual AWG members might “quite innocently” comment on the Anthropocene and expect little consequence (1x interview). With increased attention, however, any statement that was perceived to have more-than-stratigraphic implications could reflect badly on the ICS and their carefully guarded sense of political neutrality (ibid). And, while the AWG might have been overzealous, it was the media who were to blame for heightening the controversy. The media were “naïve” and were too poorly stocked with ‘real’ scientific practitioners to make sense of the complex processes involved in the production of a stratigraphic argument (2x interviews). Given the global change implications, the attempt to raise the public profile of the Anthropocene meant that the media had continually returned to the AWG over the “climate change issue” and sought to garner the group’s political and normative views on the subject (1x interview), placing “false expectations” on the group’s output (1x interview). Noting the mass of media publications in the wake of the group’s August 2016 press release - with their

certainty over formalisation and their extrapolations into the cultural implications of the concept - some of these more experienced members were frustrated to see the group's on-going deliberations "chucked back at [them]... as if [the Anthropocene] were a done deal" (1x interview), a wholly "sensationalist" account that misrepresented the process of stratigraphic inquiry and the work that the ICS was "actually doing" (1x interview). In so doing, the media had jeopardised the "mandate" of the AWG to look at the "objective evidence" as per "any other proposed interval of geological time" (ibid). In response the AWG would have to better insulate themselves from unwarranted external scrutiny if they were to demonstrate to the ICS that they were indeed going about their investigation in an appropriately stratigraphic manner. Knowing this, concerned members placed the onus back on the AWG as-a-whole to "bring [the media] into the fold in the most responsible way," to recognise their less than "benign" influence, and not let their interest in conflict or catastrophe provoke unnecessary controversy over early findings that were ill-suited for public debate (1x interview).

Learning to control their public face was not the only hurdle for the AWG. Media attention had helped the AWG to find a collective voice, grow its membership, and draw the attention of the scientific community to the Anthropocene, but it was a "double-edged sword" that risked encouraging "grandstanding" among AWG members, and risked them being drawn away from their stratigraphic remit (1x interview). When the AWG published a landmark paper in the journal *Science* arguing that the Anthropocene was both "functionally and stratigraphically distinct from the Holocene" in January of 2016 (as Waters et al 2016, p137), the rebuttal from Finney and his co-author Lucy Edwards condemned the failure of the AWG to produce a formal proposal for the voting members of the ICS to assess and respond to (2016, p6). In Finney and Edwards' view the AWG was premature in declaring the reality of the Anthropocene so publically without having first taken this essential step. The AWG might have felt confident in their knowledge of the phenomena of the Anthropocene, but they had not yet managed to prove that knowledge in a manner acceptable to the stratigraphic community. As one member noted during interview, the group were working "almost independently" from the SQS and the ICS at that time and had only been in

“intermittent” contact in the years since their establishment (1x interview) but were now working to improve communication and show them that they were “doing work from the same form” (1x interview). Perhaps distracted by their broader multidisciplinary investigation, the group had instead drifted apart from their parent bodies and had not taken account of the “important voting members” who ultimately held the power to ratify the Anthropocene (1x interview). As a result, the group had neglected to build the alliances closer to home that may have helped to support their intellectual project. SQS members were instead being made aware of the AWG’s efforts through the media, and not their journal output, and risked being given the wrong impression regarding the AWG’s arguments (1x interview).

Sensing the need to bridge this yawning divide, the incoming chair of the SQS - Martin Head - travelled to the AWG’s second physical meeting in Oslo in April of 2016 (AWG 2017). While acknowledging the group’s efforts to date, Head seemed to recognise that the group had been focused on the wrong things if their intention was to produce an argument for stratigraphic formalisation. Thus, Head presented to the group on the necessary considerations and practicalities of stratigraphic formalisation, and established that the group needed to refocus their activities on the question of locating a clear sedimentological signal for the Anthropocene. In the process, the group would need to decentre the role that their broader conversations about the Anthropocene were having in terms of both their thinking and their output. That Head - as a representative of the SQS - stepped in in this way serves to demonstrate the extent of the rift that had opened between the AWG’s looser multidisciplinary conceptualisation of the Anthropocene and the epistemic burden to which they had been established to respond. If the group were to produce a stratigraphic argument, the additional perspective that had come about as a consequence of the AWG’s eclectic composition would also have to be parsed out to produce a clear stratigraphic signal that had already been archived in the rock (2x interviews). The group’s less active members would stand down⁷³ (1x

⁷³ Some AWG members were quite candid about the limitations on their personal capacity to contribute to a more technical and stratigraphic discussion of the Anthropocene (1x survey; 1x interview), and one stratigrapher on the group acknowledged that as the group transitioned towards the production of a

interview), and without having to worry any longer about the broader implications of the Anthropocene the stratigraphers could now get on with the “easier job” of “go[ing] out and find[ing] some cores” (1x interview).

In Oslo Head drew a comparison to the Cretaceous-Paleogene boundary at the death of the dinosaurs as part of this task of reorienting the AWG’s efforts. Because of a distinct layer of chalk, the Cretaceous-Paleogene boundary is visually distinct and readily identifiable without the use of advanced instruments. Because of the clear difference in the characteristics of the rock above and below the boundary, recognition that something had changed long predated any understanding of its cause or its implications. As one member explained, early geologists were left with a ‘signal’, but not a ‘narrative’ (1x interview). Once stratigraphers had come to understand the cause - largely believed to be (mostly) the result of the Chicxulub impactor - they were finally in a position to return to the boundary itself and define it more clearly. In much the same way, Head advocated to the group that it was only upon the successful construction of a narrative of change for the Anthropocene that the AWG could make coherent progress. Insofar as the group’s work up to that point had successfully contributed to the process of forming this essential narrative of change, then that work was a necessary part of their investigative process. In effect they had to get their story straight first and figure out what it was that they were trying to say, before they would know where to draw a line in the rock. This act of bifurcating the AWG’s process between the production of a ‘narrative’ first, and a ‘signal’ to follow benefitted from the haziness with which the process of narrative formation was defined. In this retelling of the Cretaceous-Paleogene the geologists had spotted the change and then returned from the field to theorise. When they had their narrative in place they returned once more to the field to consolidate where exactly the transition had occurred. For the AWG the observation of change had been made without reference to sedimentological evidence, but the group had likewise gone on to theorise that change. Just as it had taken no real specialist expertise to discern a visually distinct line of chalk in an exposed facie, the AWG’s

formal proposal certain members “on the historical side might feel there’s less relevance to them” (1x interview).

inclusion of a number of disciplinary actors had played an essential role in their own observation. As one member argued, the paucity of contact between the AWG and its parent organisation was in some sense a virtue, giving the group the space to grapple with the phenomenon and make sense of its “shape and length and breadth, texture and colour” while they were still finding their feet with the concept (1x interview). As with the Cretaceous-Paleogene boundary, it was only once that narrative had been established that the AWG could modify their activities to account better for the specifically stratigraphic signals that must ultimately form the basis of any formalisation attempt.

Nonetheless, Head’s intervention in Oslo was an act of rescue. As one member conceded, the AWG “[didn’t] even realise themselves what they were doing until [Head] arrived in Oslo and explained it to them” (1x interview). The group was “doing what they needed to do... but now [it was] time to focus on the sedimentary record” (ibid). Seen in this way, Head’s new framing provided a justification for everything that had come before. One that served to make sense of the AWG’s efforts in a way that would counter Finney and Edward’s criticism that the Anthropocene had emerged “outside of the stratigraphic record” (2016, p6). Far from completely restructuring the work of the group, Head’s major contribution appears to be in repackaging the AWG’s efforts to appease the concerns of the stratigraphic community without necessarily requiring them to change their practice. His involvement helped the group to consolidate a set of rhetorical demarcations (Gieryn 1983; 1999; Taylor 1996; Gilbert & Mulkay 1984) that the group hoped would insulate their efforts from critique while allowing them to press forward in developing their understanding of the Anthropocene. Increasingly leaning upon the concepts that form the basis for an “ideological description of science” like ‘truth’, ‘precision’ and ‘reality’ (Gieryn 1983, p783; also Lessl 1996; Gleick et al 2010), the group learned to better communicate a vision of itself that conformed to a language of “scientific precision” that simply “reflect whatever might happen” in the world “as reality at the time” (1x interview). As far as members were concerned, it followed that if the group’s narrative of change was true then the stratigraphy must follow, an argument that overlooked the possibility that a different process of investigation might have

produced a different set of conclusions. Whatever else the group's investigation had thrown up in terms of the challenges of corralling a multidisciplinary expertise base, they were at heart dealing with a real phenomenon and about this there could be little room for disagreement (1x interview). When AWG members spoke of "sound and acceptable" scientific practice (1x survey) and of "trying to do the best science possible" (1x interview) they implied a wholly universalised vision of scientific discovery and unambiguous objectivity even as they recognised the way that multidisciplinary expertise within the group provided "different angles" for looking at the same problem (ibid).

As part of this renewed focus the group would need to jettison further consideration of the broader narrative of the Anthropocene, including the question of its possible downstream implications, and the question of its utility for other groups except where these efforts could directly contribute to the production of a formal proposal. However, in practice the group already drew a boundary around those efforts and the role that they played in their investigation. If there was an issue delineating roles, it was others and not the AWG who were at fault. As one member of the group stated, the Anthropocene was "strictly" an issue of geological time, and if people wished to use it "more colloquially" to refer to "the way the human race has changed its environment" then the onus was on them to make their intentions clear, not the AWG (1x interview; similarly expressed in 1 further interview). In this sense, it was the "outer world" that must recognise the "tricky, complicated, and multifactorial" nature of the Anthropocene and the AWG's work (ibid). As another member likewise suggested, it was others who must avoid prejudicing the group's investigation by attaching too much political meaning to it (1x interview). For the AWG the Anthropocene was an "emerging scientific concept" (2x surveys), and it was others who sought to treat it as "a metaphor" or a "buzzword" (2x surveys). While the group trusted other scientists to behave appropriately in response to the concept, the notion of a 'buzzword' in particular implied a less rigorous community of non-scientific scholars sought only to court attention and publications by using a deliberately "catchy word" with only limited "relevance to the [actual meaning of the] Anthropocene" (1x interview).

Adopting Head's repositioning of their efforts, the group's leadership spoke of "improvisation" to articulate their growing sense of the limits of what they could say without provoking further negative kickback or accusations of political bias (1x interview). The group might "occasionally... get things wrong, of course, [and] take verbal missteps, but that [was] part of the process" (ibid). In this way the notion of improvisation served to recognise that there were implications to the Anthropocene that could not be addressed through the language of stratigraphy alone (upon which the group might accidentally stumble), while maintaining a border on their own responsibility to intervene in those conversations. Group members were themselves no longer so "naive" as to think that politics played no role in the discussion of the Anthropocene (1x survey) and some members acknowledged a failure to "think anything of the ramifications" of 'anthropos' or perceive how critical scholarship might respond to the spread of the term (1x interview). Recalling time spent working with Crutzen at the IGBP, one member conceded that the focus of their efforts meant they had been acting as "their usual natural science selves" by attending to physical reality while overlooking how social scientists might also be engaged by their efforts (ibid). However, while members were impressed and encouraged by work in the humanities that had attempted to grapple with the Anthropocene and seemed aware that there were lessons to learn from that earlier exclusion, it was another challenge entirely to attend to them (2x interviews). As a result, when attempting to locate a space for social science engagement moving forwards, one member drew this notable blank:

I think it's important that we do come up with some common terminologies and it doesn't have to be the natural scientists' terms all the time, we need to learn terms from the social sciences and humanities and I think we...I'm trying to think of some examples now but I think we have learned some and changed our terminologies in some ways because of that. But I think it's important that we make sure we understand each other.

(1x interview)

Somewhat trapped between the competing demands for both openness and precision that had been placed upon their work, the more defensive stance adopted by some members suggests that a collective sense of naivety could also serve as to insulate the group from making changes that might accommodate the social sciences more fully.

The Anthropocene might have become “too popular,” applied with too many divergent meanings, and “chaotic,” but neither did members of the group see themselves as responsible for the concept’s spread or responsible for the way that others might use it (2x surveys) even as some members were willing to take credit for producing the space in which a set of broader conversations could take place (1x interview). Despite being published long after Head had joined the group, the AWG’s 2017 Newsletter dedicated 8 pages to the group’s on-going media efforts (AWG 2017, pp 17-24). And, amongst their more recent publications the group placed a highly reactive piece exploring technical criticisms of their efforts behind a paywall in *Newsletters on Stratigraphy* (Zalasiewicz et al 2017a), while submitting their forward-facing write-up of their IGC presentations for open-access publication in the journal *Anthropocene* (Zalasiewicz et al 2017b). Rather than acknowledge the more-than-scientific dynamics that had played a role in their own work or recognise the unwanted side effects of their continued desire to be highly public in their deliberations, members of the group instead described their prolific output in terms of the excellent leadership of Jan Zalasiewicz and Colin Waters (1x survey). As a result, members were broadly reluctant to respond to criticisms emerging from that space. For example, to deal with the concerns that interlocutors in the social sciences and the humanities had raised regarding the naming of the Anthropocene would simply be to “open up a can of worms,” especially given that any name change would need to be done for “scientific, and not naming reasons” (1x interview).⁷⁴

⁷⁴ One member pointed to previous changes in geological nomenclature where “old fashioned Welsh and Scottish names” like Ordovician and Silurian were replaced for the reason that those old names were simply too rooted in local geography to carry meaningful correspondence to the wider world (1x interview). Without recognising that this too constituted an effectively non-scientific rationale for modifying the terminology in use, that member similarly recognised that the Quaternary Period was maintained despite the abolishment of the Primary, Secondary and Tertiary because the community felt comfortable using the term Quaternary and to enact change would have created greater disruption than simply letting it be (ibid).

In learning how to better navigate the controversy those members with greater experience negotiating the challenges of public communication also provided a way for the group to present their arguments such that members could draw a clear distinction between the AWG as a scientific group and their own voices as concerned citizens. When they spoke in public members were instructed to say something to the effect of:

I'm a stratigrapher, I study earth history through rock, and I find there's a layer that is significant, that's emerging [and] that indicates we've left the Holocene. I'm also a parent, and resident of Surrey, and I think we need a stronger carbon tax, and I'm really worried about blah blah blah...

(1x interview)

In this way members could avoid accidentally claiming a “false authority” on the political dimensions of their efforts based on their scientific expertise (1x interview).⁷⁵ This splitting of roles served to absolve the group of collective responsibility for justifying and defending their individually politicised understandings of the Anthropocene, but nonetheless failed to recognise that any given AWG member as both ‘stratigrapher’ and as ‘concerned citizen’ was the same person. To the extent that the AWG followed this advice they would position their efforts as existing beyond ideology, while simultaneously acknowledging that as individuals they were indeed subject to ideological influence (Gieryn 1983). Thus even as they acknowledged how an informal and non-scientific ‘contingent repertoire’ (Gilbert & Mulkay 1984) informed their own thinking, the adoption of such a tactic would serve to deny the role that non-scientific thinking could play in the work on which they were to be formally judged. In a small but significant move that appears to reflect the great attention paid to the presentation of their arguments, Crutzen removed his name from a joint article with Christian Schwägerl

⁷⁵ In a similar way, the group became more careful about the issue of press releases. Before Head's arrival, excitable press officers were liable to go off-script and answer press queries in such a way that the AWG's work could be sensationalised (1x interview). Although it did little to stymie the massive flux in interest, by the time of the group's announcements in August of 2016 the AWG were forced to craft “most formal and precise and dull” press releases they could, and the University of Leicester's press officers were under strict instructions to repeat the words that the AWG provided them verbatim, treat them as straightforward communiqué “and not dress it up as they do” (ibid).

on *Yale Environment 360* (Crutzen & Schwägerl 2011) on the sustainability implications of the Anthropocene (see Figure 10). In effect, the science of the Anthropocene was to be presented as one thing, the politics another.

In this simultaneous embrace and rejection of the non-stratigraphic dimensions of the Anthropocene, the AWG pointed to what Michel Callon has called “the paradox of openness and closure (2001, p38). A sense of openness had helped the group to gain a perspective on the Anthropocene that they would not otherwise have been able to acquire. As discussed in Chapter 6, an acute sense of the political implications of global change in particular had given the group’s efforts meaning; and as discussed above, having that conversation with the public gave the group’s efforts weight. Now that the group had discovered that their openness might jeopardise their capacity to formalise the Anthropocene, there was pressure to rally around a far cleaner and more hygienic scientific narrative. In articulating his paradox, Callon describes the outside as a “disorder” that might contribute to the formulation of problems but “should not go right to the heart of scientific activity” (p39). The challenge for the AWG was in figuring out how to locate and police that boundary for themselves. Thus, where elements of subjectivity did come into their conversations, they were no threat to the “technical, objective stratigraphic discussion” that remained the group’s formal charge (1x survey), because it was the pursuit of “truth” and not future outcomes or public perceptions that served to ‘drive’ the scientific process (1x interview). They might need to remain aware of what is going on “outside”, but their own definition, and the prospect of formalisation, would remain stratigraphic in character and would be “recorded in strata” (1x interview). That the group believed that they could neatly demarcate the politics of their activities was a consequence of the ‘reality’ of the phenomenon of the Anthropocene in their thinking. As one member noted, the Anthropocene was “set apart from other political discussions” because it must ultimately “be grounded in stratigraphic evidence, rather than just in rhetoric or argument” (1x survey; similarly expressed in 2 further surveys). If there was a political dimension to their work it was because the Anthropocene was ‘real’. In effect, it was reality itself that held political consequences and the group should not be required to “supress” those (1x interview). The group’s sense that their

investigation would need to be “objective” and stay within “the frames of stratigraphy process and earth history as [they could] possibly make it” also meant that they could dismiss any ideological dimension to their discussions on the grounds that these conversations emerged naturally from the reality of the phenomenon itself, the very thing that they were tasked with studying (1x interview).



Figure 10: Image showing the strapline text from Crutzen and Schwägerl’s (2011) joint article on *Yale Environment 360*. Between 2011 and 2017 Crutzen removed his name from the by-line of the article, but the strapline was not updated to match.

The group was “not... lobbying” because they did not seek to actively influence the policy making process (1x interview), rather they only wished to inform the policy making process with the very best science to hand. As a result the group could make sense of their own more politicised interventions in terms of an obligation to the public. In this way, members asserted that there was “nothing ideological behind this, we’re just telling the people what we are describing as scientists [because] we should report everything we know” (1x interview) and that it would have constituted a form of censorship were they to “suppress” the implications of their work (1x interview). In any case, the accusation of playing politics with the Anthropocene should not diminish “their

overall ambition of trying to inform people about climate change and coming up with what we would see as desirable directions and policies” (ibid). The affordance of a politics to their efforts was “not necessarily... a bad thing” because the public conversation had been reluctant to fully embrace climate change and seek to act on it (ibid). After all, the group was “not developing the H bomb,” but rather developing an unquestionably positive piece of informative science (ibid). If the group did cross the line into a space that might be explicitly political, their transgression was justifiable because the game was rigged anyway. There were already so many vested interests attempting to distort environmental and earth science (1x interview). Where others were “following the lead of the old Soviet Union in trying to bend the science to fit the ideology of political leaders,” the group were simply telling it how it was (ibid).

9.4. The Best of Both Worlds?

Despite adopting a more explicitly neutral stance in order to protect their chances of satisfying the stratigraphic community, the AWG nonetheless maintained that they were doing something fundamentally new and different. Buried in members’ suggestions of an ‘appropriate kind of expertise’ subject to the specific criteria of stratigraphy and stratigraphic methodologies (Taylor 1996, p203) were broader questions about how much of the nascent Anthropocene controversy stratigraphy as a discipline could on-board into their own practice. The discipline of stratigraphy might be able to respond to the technical question of stratigraphic value, but in doing so it had to address how much those other considerations should influence the practice of stratigraphy in the future. The group might manage to demonstrate the Anthropocene and its signals of an overwhelming of the natural world through the language of stratigraphy, but the problem was conceptual and not only material. The AWG’s output suggested that their vision of the Anthropocene was defined by the “transdisciplinary programme” of ESS (Seitzinger et al 2015, p5) and also by the political understandings of individual members. Were the ICS to ratify the Anthropocene they would need to render humans as a “change wrought by the internal dynamics of the [earth] system” (1x survey) or invite the far broader engagement that the AWG had themselves occasionally touched upon in their more

public pronouncements. As a result the challenge became a conceptual quagmire around the role of stratigraphy and whether the discipline should say something more of the social processes that had given rise to an epoch called the Anthropocene, or whether the group should simply offer a point of demarcation even as they recognised that drawing a line in the sand was not to tell the entire story (1x interview).

Unable to square this circle for themselves, the group seemed willing to shift the blame for failing to recognise the value of their efforts onto others. Thus, while the group might understand stratigraphy as a pragmatic endeavour, this was not matched by their sense of other practitioners in the discipline or of those voices like Finney whom they perceived to stand in the way of their vision of the Anthropocene. In contrast to the lay communities who - by virtue of the 'informal' Anthropocene - had been eager to recognise the importance of the Anthropocene even if they had not used it in a strictly stratigraphic sense (1x survey), stratigraphers were said to be a "traditional, conservative community," that had an "understandable" but "[inherent] resistance to change" (1x interview), and were unwilling to recognise how the discipline might evolve "despite any facts to the contrary" (1x survey). While those voices might speak truth to their own experience of the field, they had not experienced for themselves how the ground game had changed and they had been left behind as a result (1x interview). Due to this "conservative attitude" (1x survey) AWG members recognised a risk that the ICS would preference tradition in their decision-making (1x survey). Thus, even if the AWG could persuade old school stratigraphers that the Anthropocene was indeed worthy of stratigraphic consideration, there was a sense that the novelty of Anthropocene materials created additional barriers to comprehension (1x interview). Novel concepts like 'Technofossils' and 'Anthroturbation' - as discussed in Chapter 6 - might go some way towards illustrating how the Anthropocene could be understood through the language of stratigraphy, but the production of these new concepts was not, in itself, enough. As one member noted, that older generation were "trained to believe" that humans could not have such a prominent impact on the planet's geology (1x survey). In the view of the AWG, these traditionalists simply could not conceive that the early events of their own lifetimes might belong to another epoch (1x survey; 1x interview),

and there was not a “large [enough] community of scientists working on recent sediments” for scholars to pursue peer recognition by working with more recent deposits (1x survey).

In this way - for some AWG members at least - resistance from the stratigraphic community derived from misconceptions about the nature and extensivity of the evidence, and not from questions of whether or not that evidence was ‘valid’ (1x interview). As one member suggested, the geologists and biostratigraphers who made up the ICS struggled with the “top-down global approach” of the Anthropocene concept as it had developed through ESS (1x survey). As a result, the nature of evidence was simply “that much more unfamiliar to the average working geologist” who would have been more familiar with much longer timescales (1x interview). Lacking the appropriate expertise, voting members were instead likely to be swayed “without fully considering the arguments fairly” (1x survey). With recourse once more to the ‘reality’ of the Anthropocene phenomenon, it was the rules of stratigraphy that were at fault and not the way in which the Anthropocene might be thought to be discontinuous with those rules. The AWG might have to parse out the complexity of their own bigger vision of the Anthropocene in order to sell it to the stratigraphic community, but this was due to the “plain rules for stratigraphy” (1x survey) and “the on-going requirements of the commission” (1x survey). In this sense, it was the AWG whose efforts represented ‘good science’ and not those conservative stratigraphers who were fixated “on a small number of biotic signals without considering the wider changes occurring across boundaries” (1x survey; 1x interview). While the AWG might have been accused of playing politics with science, it was the ICS and IUGS that were being political with their supermajority process of votes and ascension inviting “politicking” over the location of GSSPs (ibid; also Oldroyd 2003, p109).

Rather than allow historians or philosophers of science to explain the dispute upon resolution, members drew upon Kuhn’s notion of a ‘paradigm shift’ to make sense of the gulf between the vision of the Anthropocene that they held, and that which they believed that the ICS would accept. Rather than a mere “geofantasy” (1x survey) the

stratigraphic community must recognise that their “conceptual framework [was] no longer functional” (1x survey). By drawing in ESS they had enacted a “paradigmatic shift” (Steffen et al 2016, p325; Hamilton & Grinevald 2015) that could provide a suite of new - transdisciplinary - insights to which stratigraphy might now respond (2x interviews; 1x survey). To the extent that the AWG’s achievements had been sufficiently unprecedented as to attract an enduring group of adherents away from competing modes of scientific activity - and were sufficiently open-ended to leave all sort of problems for a redefined group of practitioners to resolve - the group’s efforts might reasonably be considered in terms of a Kuhnian paradigm shift (see Kuhn 1996, p10). However, because the ‘what’, ‘how’, and ‘why’ of the Anthropocene were still subject to on-going controversy it was somewhat harder to suggest that there was in place a shared commitment to a set of roles and standards for scientific practice within this supposed new paradigm (p11). Instead, the notion of the paradigm shift served a performative role. It was another line of argument that the group - and other proponents - could draw upon to resolve conflict by suggesting that opponents were simply wrong (Cowen 2015, p181 see also Hamilton 2014b; 2016a; Lewis & Maslin 2015a; 2015c).⁷⁶ By suggesting that they rode the crest of a new kind of science with better explanatory power, the group could protect their interest in seeing the Anthropocene formally ratified by doubling down on the powerful scientific narrative of the human mind gradually gaining representational mastery over external reality (Golinski 2005, p3; also Rheinberger 1997).

While some members were sceptical of the AWG’s space to reinvent the wheel regarding the stratigraphic process (2x interviews), if others in the group were successful in advocating that the paradigm for global change science had indeed changed then all disagreement with the ICS would become little more than a function of the time it would take for the group’s arguments to be proven correct and accepted as such. Time would “out” the truth (Gilbert & Mulkay 1984, p4), because the evidence was “overwhelming” (1x survey), and the “weight of [that] evidence” could only lead to one

⁷⁶ This strategy was not unique to the AWG. William Ruddiman likewise drew upon the concept of the paradigm shift, alongside Karl Popper’s notion of ‘falsifiability’ to demonstrate the inability of scholars to disprove his argument for early anthropogenic climate influence (2016a; 2016b; forthcoming).

“logical” outcome (1x survey). The group spoke of an unpublished “grass-roots support” to match the high profile criticisms of Finney and Edwards, and in so doing implied a sense of momentum that would ultimately carry their truth to light and overcome inertia within the discipline of stratigraphy (2x surveys). Searching for confirmation that their vision of progress would ultimately come to pass, the group drew upon group member and historian of science Naomi Oreskes’ prior work on plate tectonics (2003). While a theory of plate tectonics was first conceived of in the early 20th Century, it had struggled to gain widespread recognition until the early 1960s. However, because plate tectonics eventually became a fundamental component of the geological understanding of the earth (see Miall 2016, pp 9-11), members could remind themselves that ideas of a “certain radicality... take time to seep through” (1x interview). Offering much the same argument when the AWG met in Oslo, one member used their presentation to remind the group that they were not alone in the history of science in receiving backlash for a new idea of great importance (Figure 11).

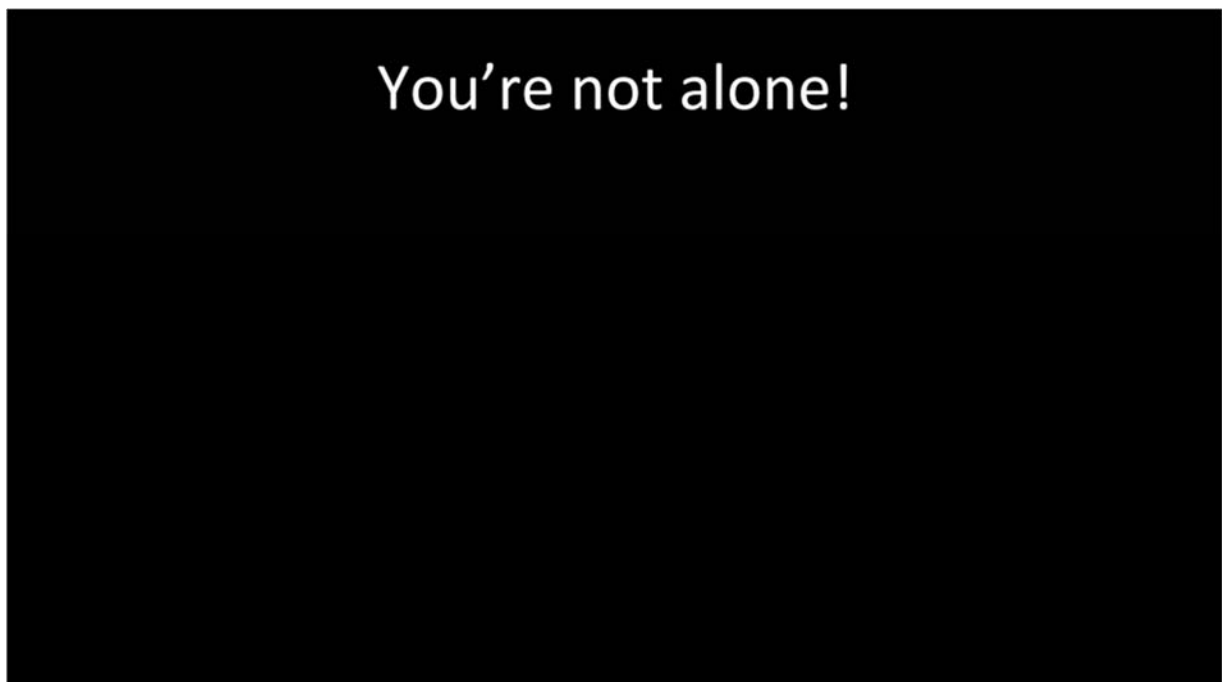


Figure 11: Slide from a presentation at the AWG’s second physical meeting in Oslo in April 2016 which argued that just as Darwin was hounded when he first posited a theory

of natural selection, so too would the group be attacked by traditionalists before their logic was ultimately accepted (shared by presenter).

However, the AWG did not apply this line in every context. Addressing the controversy for a dedicated community of stratigraphers in *Newsletters on Stratigraphy* the AWG sought to counter Finney and Edwards' criticism that the Anthropocene was an external discourse with limited relevance for stratigraphy. The concept might have emerged from "outside the discipline" as Finney and Edwards had suggested (2016, p6), but the AWG were nonetheless investigating it as they would for any other stratigraphic hypothesis (Zalasiewicz et al 2017a). Far from the paradigmatic shift or 'rupture' that members had embraced and were willing to present in publications for a broader audience (Steffen et al 2016, p325; Hamilton & Grinevald 2015), the members wanted to make it clear that while their arguments might represent a challenge for some stratigraphers this was to be achieved "at no more of a revolutionary rate than [had] already been done" (1x interview). Defending the need for such a change the members drew attention to the contingency of the Holocene's journey to formal ratification. While that boundary could have been identified in (traditionally acceptable) lake and marine deposits, the ICS ultimately accepted an ice-core on the grounds that it was the most effective representation of the transition from the Pleistocene to the Holocene (Gibbard et al 2010). Thus members noted how in contrast to previous GSSPs - which have physical bronze plaques that can be visited - the Holocene GSSP was "basically preserved in a fridge" and inaccessible "unless you have a few million dollars to spend" (1x interview). Because the Holocene was a effectively a 'special case' due to its novel use of an ice-core over marine sediment, there was an argument here that the Anthropocene ought to receive the same benefit of the doubt (1x interview; similarly expressed in 1 further interview).

For some members then, the novel aspects of their argument for stratigraphic formalisation were "no more radical" than the way in which the rules were reshaped around the need to formalise the Holocene (ibid). Paying particular attention to this useful example of the ICS breaking their own rules, the members were able to point out

a number of commonalities between the Holocene and the Anthropocene. On-going discussions over the question of whether to formally subdivide the Holocene into a number of 'stages' - smaller subunits of lower hierarchical status - had revealed that the Holocene Working Group also justified their arguments as the "logical" response to what was already "current custom and practice" (Walker et al 2012, p652).⁷⁷ While Holocene Working Group members denied that there was any similarity between their efforts and those of the AWG (1x email), this was the very same epistemic burden at the heart of the AWG's own efforts. If the challenge of talking about humans within a geological context was a step too far with the Anthropocene, the Holocene Working Group had likewise built their case with the help of both sedimentological materials and the "cultural proxies" of early Neolithic societies (Walker et al 2012, pp 653-654). Returning once more to the reality of the Anthropocene, the AWG members conceptualised stratigraphy as a pragmatic discipline and pointed to their responsibility to work with what they had (1x interview). Novel materials and novel methods were simply a part of the process of identifying the "the most effective boundary" for change (ibid). Irrespective of their novelty, they were the signals for change the group already knew to be real. After all, the signals were "just signals, whether they [were] novel or not" (ibid). In this sense, this new paradigm was incorporated into the stratigraphic material itself and rendered self-evident. As another member noted, "every unit is different. If it weren't it wouldn't be a unit" (1x survey; similarly expressed in 1 further survey).

For all that the AWG sought to differentiate their own efforts from the conservatism and traditionalism of the ICS, they relied on a fluid conception of those traditions. As one member noted, for all the talk of a new paradigm, the group was basically unwilling to jettison the Holocene, despite member repeatedly referring to that epoch and its formal status as "thin soup" (1x interview). Offering a sympathetic view of the ICS's plight, another member noted that "if you change the definition of something drastically, you create a break between current usage and historical usage and you sever the link between current usage and the literature, which may be vast" (1x interview). As a consequence, the AWG were bound by a desire to make the Anthropocene sufficiently

⁷⁷ This tripartite division of the Holocene into stages was later formally ratified in June of 2018.

different that it would be worthy of inclusion in the International Chronostratigraphic Chart, and yet consistent enough that the relevant community of stratigraphers would recognise that it could be included without it undermining other divisions in the chart. As with the group's careful positioning over their responsibility for the political implications of the Anthropocene, the group had come to embrace a set of contradictory positions. Where others in the broader controversy saw the group as lacking in transparency and admixing scientific fact-making and political ideation (Malm & Hornborg 2014; Bonneuil & Fressoz 2015; Cobb & Howell interview), the group painted themselves as pushing against an unmoved institutional inertia. And, where disciplinary voices sought to defend their understandings of stratigraphy (Edwards, Harper & Gibbard 2017; Finney & Edwards 2016; also Autin & Holbrook 2012) the AWG imagined that it was they who held the best interests of the discipline at heart. Theirs was, after all, a "hopeful transdisciplinary" vision of great "epistemological novelty" worth pursuing in the interests of scientific progress (1x survey). As a result, the AWG were both an 'outside' group because of their desire to enact a conceptual shift to the discipline (Lewenstein 1992, p156), while simultaneously an 'inside' group as a result of their commitment to science, objectivity, and their belief in the continuity of their efforts.

But if the whole point of this new paradigm was to install a broader multidisciplinary perspective at the centre of a new vision of stratigraphy - even if done in the interest of pragmatism - then some members felt that the Holocene must similarly be abandoned. Instead, the same kind of careful and pragmatic thinking that had led to the formalisation of the Holocene meant that it was in some way advantageous to keep the Holocene in place. References made to 'the envelope of Holocene variability' in much of the pro-Anthropocene literature emerging from both the AWG, ESS, and sustainability communities (for example Steffen et al 2015; Zalasiewicz et al 2014; Waters et al 2014a; Steffen et al 2011a; Rockström et al 2009a; 2009b; Steffen Crutzen & McNeill 2007) gave the Anthropocene an essentially natural state against which to contrast, even as this variability referred to an extremely narrow window of time (1x interview). In this rendering, the Holocene had less to do with a pragmatic division of geological time and more to do with viewing the Holocene "as a state of the system" with its own

stability and its own characteristics” (1x interview). It might be fair to suggest that as a group the AWG wanted the best of both worlds: to prove that the Anthropocene mattered to stratigraphy even as their investigation illustrated a variety of ways in which they might move beyond stratigraphy alone. Recognising this challenge, some members suggested creating a new space for that more ambitious kind of investigation such that the integrity of stratigraphy might be preserved. In this way, a new and different body would be free to commit to the “wider consideration of and investigation of the impact of human activity” that the AWG had begun to perform without placing pressure on the ICS and its subcommissions (1x interview). For some members, however, this was not enough to resolve a more fundamental problem. Feeling that the AWG’s more than stratigraphic investigation had instigated a change that could not be reversed, one member suggested that “a new human systems field” driven by social scientists who could operate at the earth system scale “will just upend the whole thing” (1x interview). These scholars would - in this member’s view - enact that change irrespective of how the controversy was resolved in the stratigraphic community. While my analysis has demonstrated that the complex negotiation at play in the AWG’s efforts and how these helped to drive their scholarly output, Erle Ellis was the only member to publically stake a claim that the group had reached the end of its useful life in its current form. Writing in the journal *Nature* in late 2016, Ellis - alongside Mark Maslin and archaeologists Nicole Boivin and Andrew Bauer - advocated for the establishment of an entirely new body for formalising the Anthropocene. In Ellis’ words this new body - to be called the International Anthropocene Commission - “must be more transparent and have wider input and assessment,” and would draw in the institutional apparatus of the IUGS,⁷⁸ Future Earth, and the United Nations Intergovernmental Panel on Climate Change (Ellis et al 2016, p192). Recognising the increasing role that these disciplines were playing in the controversy as a whole, this new commission would establish criteria to enable it to better engage with historians, sociologists, geographers, ecologists, economists and philosophers alongside earth science communities (ibid).

⁷⁸ Here misnamed as the International Geological Congress, that event having recently taken place.

Despite Ellis et al trying to present a vision of the Anthropocene that would appease everyone, his attempt to bring together the fractured dynamics of the controversy was met with strong criticism across the board. AWG members Jan Zalasiewicz, Colin Waters, and Martin Head - speaking for the group as a whole - responded in *Nature* to express their dissatisfaction with the way that Ellis had presented the Anthropocene. Stating that stratigraphic formalisation would not confer the “holistic analysis of all human impacts on earth” that Ellis et al had advanced in any case (2017, p289), they instead sought to maintain the neat rhetorical boundary around their efforts that would preserve the Anthropocene as a distinctly stratigraphic, scientific concept. Writing in defence of their more conservative vision of stratigraphy, the AWG’s own Philip Gibbard and the US Geological Survey’s Lucy Edwards criticised Ellis et al for suggesting that the earth sciences had moved entirely beyond “defining precise stratigraphic boundaries to developing records of continuous change” (Edwards et al 2017, p464). It was disingenuous, in their view, to draw upon the authority of the International Chronostratigraphic Chart and its clear divisions in time to bolster this essentially non-stratigraphic discussion of global change. Finally, adopting the voice of the social sciences, Noel Castree took objection to the way in which Ellis et al still set their sights on a vision of formalisation (2017a). Intuiting a fundamental misunderstanding of the role that the social sciences could play in furthering discussion of the Anthropocene, Castree saw Ellis et al as instead attempting to leverage the additional authority the social sciences might provide. Rather than a genuine gesture towards inclusivity, it was a “misguided attempt to ‘scientize’ a particular set of value judgements” about how humans should respond to change (p289). Despite his attempt to bring all the relevant disciplinary stakeholders to the table, it seemed as if Ellis had in fact alienated them all.

9.5. Conclusion

I began this final empirical chapter by exploring the expansion of the Anthropocene controversy into a variety of semi-public spaces, and I used this movement to illustrate the implications of the controversy as a whole for the practice of the AWG. I paid particular attention to the acts of boundary work (Gieryn 1983) and rhetorical demarcation (Taylor 1983) through which AWG members came to make sense of a controversy over which they had lost control. The AWG's efforts to do something novel with the Anthropocene and with stratigraphy had been a consistent feature of their work. But making that conversation too public too early had only exacerbated the frictions that might otherwise be viewed as par for the course in scholarly debate. Thus, at the heart of these demarcations was a paradox of openness and closure (Callon 2001) by which the AWG both benefitted from additional, multidisciplinary expertise, and yet downplayed both the role that it had played in their investigation and the responsibility that they would have to speak to the broader dimensions of the Anthropocene controversy. As a result, the group sought to satisfy the ICS's requirement for political neutrality through the careful splitting of roles and with reference to the material reality of the Anthropocene itself. Individuals might hold normative views, but the group had always been objective and scientific in their thinking. And, if there were political implications to the Anthropocene, these derived from the reality of the phenomenon itself. In this way, the group sought to step outside of the controversy in which they were unavoidable entangled by presenting a vision of their scientific efforts that were at once value-free, and simultaneously interwoven with values for which they were not 'accountable' (Gieryn 1999, p17).

Likewise, I noted that AWG members might have believed themselves to be at the forefront of a paradigmatic shift for stratigraphy, but they were nonetheless willing to draw attention to the consistency of their efforts with regards to previous divisions in geological time. Their ideas might have been new - and the Anthropocene itself might have represented something truly different for stratigraphic inquiry - but they understood the discipline to be fundamentally pragmatic in its approach. So long as this held, the

group could again make recourse to the reality of the phenomenon of the Anthropocene to resolve tensions with the ICS about the multidisciplinary nature of their investigation. While the AWG's decision to present the Anthropocene as both novel and consistent was a source of tension within the group, it demonstrated how the group benefitted from the fluid disciplinary status of the Anthropocene. Despite the group's belief of the better explanatory power provided them by their on-boarding of multidisciplinary expertise, they nonetheless benefited from their association with the traditional authority of stratigraphy. In effect, the group had positioned the Anthropocene in a transient space between and beyond any recognisable disciplinary status, leaving stratigraphy-as-practiced decentred from their investigation, and yet essential to its success. This was a space in which the group could throw the shackles of the discipline while producing what they hoped would ultimately be recognised as a stratigraphic fact. The irony being that this manoeuvre could only succeed so long as the group could make the Anthropocene recognisable to a community whose particular disciplinary expertise they seemed keen to move beyond.

Chapter 10: Conclusion

10.1. The Status of the Anthropocene Controversy

AWG chair Jan Zalasiewicz's (2008) pop-science introduction to the stratigraphic legacy of humankind, *The Earth After Us*, neatly encapsulates the outstanding challenge to stratigraphy represented by the Anthropocene controversy. Starting with what we already know about both earth processes and the extensivity of anthropogenic impacts, Zalasiewicz knowingly "pre-construct[s]" (p5) a plausible vision of how that might be represented in the rock record one hundred million years hence. At the same time, the book's science fictional framing involves the arrival of a group of wholly oblivious alien explorers to earth. These aliens must then reconstruct the history of earth in order to make sense of the species that had caused their own climate apocalypse. Expressing great pride in the process of stratigraphic inquiry, Zalasiewicz makes it clear that his aliens ought to be able to discern a great deal about the history of the earth and should even be able to tie climatic upheaval to the emergence of a single highly dominant species. However, in drawing a comparison to the way in which we still debate the function of Stonehenge despite a reasonably good understanding of the society that built it, Zalasiewicz's alien protagonists can only infer a coarse narrative from the material available to them. He leaves particular speculation about the what, how, and why of that change "irresolvable and fruitless" (p219).

There are two lessons in Zalasiewicz's story for the Anthropocene controversy as I have understood it here. The first is in illustrating the complicated pretext Zalasiewicz was forced to create in order to apply a practice that has been historically used to make sense of the past that he now wished to apply to the future. It was the very same conceptual challenge that drove the AWG to draw upon wide-ranging multidisciplinary expertise from beyond the borders of stratigraphy when they began to develop their case for stratigraphic formalisation. Much like Zalasiewicz's 'preconstruction' of the future, the group already understood the Anthropocene to be a real phenomenon. Their challenge was simply to match that support with a set of evidential lines that could be

understood as sediments. It was the complexity of achieving this in practice that led some in the group to believe that the Anthropocene would drive change in the epistemic practice of stratigraphy. Second, much as with the story Zalasiewicz's aliens are able to piece together of earth's history, the narrative we end up with after the fact will always be coarser than the one that can be constructed in the here and now. Borrowing Zalasiewicz's framing, sociologist Bronislaw Szerszynski likewise conjures a committee of far-future aliens to proceed over the ultimate resolution of the Anthropocene controversy (2015). Given the inherently speculative nature of earth system modelling - in response to which the manifestation of changes in the rock record can only ever exist in a lag-state - it seems inevitable that any future reflection will be granted a clarity that the present simply cannot match. The same is true of a controversy that is not yet resolved. However, there is great value in exploring things in-the-making, before we are left with no idea as to how they came to be (Collins 1975). As Hans-Jörg Rheinberger has noted, once a consensus has been established over the production of a set of facts or an idea, and once the system that was generative of that consensus stabilises and begins to play out "its own intrinsic capacities," the outcome is likely to look like it was completely inevitable (1997, p24). Once settled, a newcomer would not only have a lesser capacity to reshape those facts, but it would be more likely that they would have to accept the logic of that settlement as a necessary precondition to any work they might wish to do (p186).

As explored in this thesis, the use of the Anthropocene through to late 2016 ballooned through a confluence of factors beyond the growing recognition of the extensivity of anthropogenic impacts on the planet alone. These included: the confident embrace of the Anthropocene amongst the ESS community, the AWG's reciprocal confidence in building and broadcasting the stratigraphic case to support it, and the desire of a range of interlocutors in other disciplines to use a new tool to reinvigorate a set of disparate intellectual agendas. The endlessly fractured informal, but fundamentally 'metastable' (Rheinberger 1997, p226), vision of the Anthropocene that emerged as a result represents a fascinating state of affairs. Both worthy of consideration in its own right, and not reducible to a simple waypoint in a broader story not yet complete. That said,

that stability may yet give way, the context of that stability may yet alter, and researchers and scientists may move on to pastures new (ibid). Some interlocutors would argue that the controversy was remarkably successful insofar as it generated a wide-ranging conversation about human impacts across a number of disciplines. And, recognising that the ultimate outcome of the controversy is not yet decided, may feel content that the longer-term outcome of the controversy will result in the reshaping of epistemic practices such that they were left more open to the input of multidisciplinary expertise. Both outcomes have less to do with the Anthropocene concept itself and more to do with the kinds of social relations that the concept served as a vehicle to deliver. Jamie Lorimer has suggested that the Anthropocene “will leave its semantic and sensory traces in popular practices and lexicons” irrespective of stratigraphic formalisation (2016, p123). Adapting his intended point, the impact of the Anthropocene controversy may indeed outlive the concept itself, and may ultimately prove to be more profound. The Anthropocene retained its central place in this thesis precisely because it was visible, with the controversy playing out in such a way that it could be meaningfully traced. While certain impacts of the concept will undoubtedly linger, the ‘Anthropocene’ itself may yet fade into the margins (Rheinberger 1997, p226). If and when that happens, the more complex story of its origins I have tried to tell here will be much harder to reconstruct, and the concept itself may be of less importance than the various impacts it will have had.

For now, I have explained how the Anthropocene was articulated, how it was driven to prominence, and the form it took as a result (p229). And, I have paid attention to why interlocutors were willing to engage with the concept. The period from 2000 to 2016 saw the creation of a new geological epoch that was variously adopted and forwarded to differing ends. An epoch that for some actors and institutions represented a fact - albeit one that carried a set of normative obligations - and for others sat at the other end of a loose continuum as a (politicised) heuristic that nonetheless reflected external reality in important ways. That the Anthropocene could serve as a fact for some, and a heuristic for others intuits a broader challenge regarding the way in which different modes of thinking interact over nominally shared concepts. I have also shown how the

Anthropocene was given meaning and structure by different actors and institutions, and how it served variously as an opportunity and as a threat. It was, for some, an opportunity to press home the impacts of global change, an opportunity to think in new ways about the planet, and an opportunity to upend the epistemic practices of a number of disciplines. For others however, the popularisation of the concept threatened to override well-established practices and a system of communication and collaboration. Not only did the concept's popularity risk subsuming smaller - 'invisible' - disciplines, but it also risked masking unavoidably political considerations behind the sheen of technical discussion. Despite wide-ranging differences in what the Anthropocene stood for and what it might be used to 'do', the Anthropocene was - and remains - bound together by a commitment to agree that there is indeed mileage in the concept.

10.2. Further Avenues for Research

Before returning to the research questions that structured my investigation, I want to briefly acknowledge the ways in which the analysis I have presented here might be extended with further work. And, I would like to illustrate some areas that my data touched upon but did not offer a complete enough picture with which to sustain that further work. For one, there is more to say about the complex and entangled motivations of interlocutors that had less to do with scholarly concerns regarding science or politics but which nonetheless exert important influences on the performance of modern scholarship. For example, certain interlocutors were unexpectedly candid about the role the Anthropocene played in helping progress their careers. Some participants in this research noted the value of the Anthropocene as a way to develop opportunities and build publication lists, whether in the early days of a career (1x interview) or at its mid-point when seeking to maintain relevance and impact (1x interview). Viewing the impact of the controversy on their career and reputation in more complex terms, one participant noted the regularity with which they were being invited to attend conferences and discuss the concept and its implications. Despite a career outside the Anthropocene, they felt that they had become typecast as "someone who has something to say about this" (1x interview).

Steven Shapin (2008) has noted how the professionalisation of the sciences led practitioners to view their work in terms of a job more so than as a calling or act of civic responsibility. These honest snippets hint at a further conversation to be had about researchers as invested and institutionalised actors, and not simply as disinterested conduits between the 'real' and 'social' worlds (see Boehmer-Christiansen 1994a; 1994b). My analysis highlighted the complex trade-offs made by interlocutors in pursuit of disciplinary visibility. Further work could expand upon the complex relationships that scholars had with the Anthropocene to account for the environment in which scholars operate and the growing pressure to produce 'impactful' research (Bornmann 2012). In an active controversy where scholars were already concerned about the epistemic privileging of other disciplines - and could fear losing standing were their efforts understood to be too opportunistic - it might be hard to generate honest accounts in this space. For example, one participant seemed acutely concerned that his engagement with the controversy might be seen as "bandwagon jumping" (1x interview). Absent recourse to the 'facts' alone, my participants in the social sciences and the humanities were generally less candid about this dimension to their work, and instead structured their own engagements with the controversy around their 'need' to respond and the 'good' political and intellectual rationale they had for doing so. There could be great value in a project that made sense of how scholars choose topics and pick their battles. Any lessons learned would have general value, but could also enhance understanding of how a controversy like the Anthropocene came to play out.

Beyond this, there is something further to say about institutional interests in a more general sense. The possibility that the AWG's efforts were driven by the lucrative funding opportunities associated with a provocative new 'buzzword' was a particular point of contention for some interlocutors in the controversy. Feeling under threat of disciplinary erasure, two of my participants had escalated their rhetoric in response to the AWG's vision of the Anthropocene in part because they felt that the group were benefiting from generous grants in forwarding their claims. In effect, they felt that their strong language could achieve what their lack of resources could not (1x interview).

AWG members stringently denied the suggestion that the group benefitted from such money. Conversely, it was the very lack of funding that kept the AWG honest, because if they wanted additional resources they would have to go out and make the case for them like everybody else (1x interview). Nonetheless, the question of grants and funding were felt in other ways. For example, it remains clear that the University of Leicester has an on-going interest in the Anthropocene concept and wants to capture the growing market for ideas on the topic. One AWG member spoke about the advantages conferred by Waters' move to an honorary professorship at the University of Leicester, and how it would allow the university and the British Geological Survey to pursue collaborative projects in a way that was mutually beneficial (1x interview). Elsewhere, the British Society for Geomorphology Fixed-Term Working Group had felt motivated to intervene in the controversy precisely because of the funding implications that formalisation might hold (1x interview).

Another avenue for further research would be to explore the way in which the Anthropocene penetrated into the teaching of a number of my participants, both within the AWG (2x interviews) and in the broader controversy (3x interviews). I also note the publication of undergraduate textbook, *Environmental Transformations: A Geography of the Anthropocene* by geographer Mark Whitehead (2014), used to structure a dedicated undergraduate course in at least one UK University. The diffusion of the Anthropocene into teaching is already starting to make itself apparent. In 2014 doctoral candidates Alexis Mychajliw and Melissa Kemp published in *The Anthropocene Review* on the prospect of “using the Anthropocene as a... communication and community engagement opportunity” alongside their supervisor Elizabeth Hadly (Mychajliw, Kemp & Hadly 2014, p267). As one of the trio noted during interview, Hadly is a long-time collaborator of the AWG's Anthony Barnosky, having most recently co-authored the 2015 book *End Game: Tipping Point for Planet Earth?* (1x interview). With Hadly having adopted the concept as a result of that existing relationship, the trio now sought to pass the concept on to another generation of students (ibid). In all cases it would appear that those now seeking to use the Anthropocene in their teaching sense an opportunity to impart their own understanding of the concept. AWG members are liable to teach their

students their own understanding of the rules of the ICS and why exactly the Anthropocene can and should be appended to the International Chronostratigraphic Chart. On the other side of the controversy, Whitney Autin has used his undergraduate lectures to complain about the AWG and the politics of their efforts (Autin 2014). Ascribing entirely different value, two of my participants expressed a real enthusiasm that the Anthropocene might provide an opportunity to explore with students why it is that physical and human geographers do not always see eye-to-eye (2x interviews). Speaking from their own experience, one noted that undergraduate students start their first year bewildered by a new concept they have never encountered before, only to end their final year bored of a “truly academic” debate (1x interview). Further work in this area would no doubt be fascinating, but there is little evidence at present that the Anthropocene has yet entered into the syllabus of undergraduate teaching in a consistent manner, and it remains unclear as to whether the Anthropocene will develop a foothold in postgraduate research training. As a result, a more comprehensive exploration of whether or not teaching is a generative space for the Anthropocene controversy - or simply a site in which new minds are disciplined to the perspectives of their instructors as they are inducted into particular communities (see Abbott 2001, p126) - lingers as yet unanswerable.

Finally, it would be fascinating to return to the Anthropocene controversy when the AWG do present a formal proposal to the SQS, the ICS, and IUGS. By that time those bodies may have been completely convinced of the need for an Anthropocene, but the opposite may be equally true. While one Holocene Working Group member recognised that they might be seen as a “bunch of conservatives who didn’t realise the importance of events currently going on” (1x interview), I am not convinced that old hand stratigraphers are going to accept the logic of the Anthropocene any time soon. In one such view, the current “high sea level, lack of glaciation, presence of a warm and temperate climate in places such as [the UK]” means that the criteria of the Holocene still hold, even as they recognise the very real harm that human activities are having on the planet (ibid). Stan Finney - who was such a vocal critic of the AWG - may have finished his tenure as Executive Chair of the ICS, but he will serve instead as Executive

Secretary of the IUGS, the next rung up on the institutional ladder through until 2020.⁷⁹ Then again, these voices may soon retire out of the system or be otherwise outvoted by more sympathetic young stratigraphers with a different set of understandings regarding the International Chronostratigraphic Chart and stratigraphy's role in shaping it.

While they were not my primary focus, such structural interests were a recurring context for this thesis. These included the role that Crutzen's Nobel-prize winning status played in the controversy (Chapter 4), the role of a 'cycle of credibility' in the further promulgation of the Anthropocene (Chapter 8), and the pressure felt by some interlocutors to use the Anthropocene as a way to prove their commitment to societal relevance (Chapter 9). In performing my own analysis, I explored the views of individuals as they have navigated these structures and I attended to individuals in their attempts to speak on behalf of the disciplines they represent. It made sense to perform this analysis first. As individuals, both my participants and those others whose works I explored were at the cutting edge of the controversy, making sense of these structures in real-time through their very engagement. However, over time - much as a vision of the Anthropocene was consolidated through the formation of specific journals - the concept will no doubt find some more clearly institutionalised form. Once these institutionalised forms - be they grants or curricula - have had the opportunity to bed-in there will exist the necessary materials to perform further analysis. Following this, a valuable next step would be to map the largely individual stories told here against a broader structural context. Such work could include the publishing norms of science that make it essential for 'good academics' to churn out work, contribute to public debate, and add their stock to the store of knowledge (see Johnston 1998). And, such work might also consider how the neoliberalisation of the university has created ever-greater pressure for scholars to use faddish concepts like the Anthropocene to be heard (see Buranyi 2017). This work could enhance what I set out to do here, rather than replace it.

⁷⁹ <http://iugs.org/index.php?page=directory#EC>

10.3. Disciplinarity, Epistemic Friction, and the Anthropocene

Having addressed how further study could enhance my findings, I now return to the research questions established in my introduction. My first question asked what the Anthropocene concept was, and who was involved in its spread. While the Anthropocene was in some sense simply a new epoch of geological time, the answer is in truth more complicated. As my analysis has made clear, the concept meant different things to different individuals. Nonetheless, if there was one consistent definition to the Anthropocene that was largely shared it related to the idea that the Anthropocene straddled a contested boundary between scientific observation and political intervention. In consolidating the Anthropocene, Paul Crutzen did not fabricate the observations from which he synthesised this new concept, but his primary motivation in committing ink to paper was in illustrating the extensivity of human impacts on the planet in order to provoke a very specific kind of response. From this point onwards, the controversy played out as an extended treatise on the appropriateness of this move, with the different responses of interlocutors holding - after a fashion - to pre-existing disciplinary allegiances. Stimulating the need for other disciplines to respond, the IGBP and the broader ESS community saw in Crutzen's blending of scientific fact and moral impetus an opportunity to press the need for a response to anthropogenic global change. Drawing a dizzying array of impacts together into a single concept, they had found a silver bullet to reinvigorate the climate conversation.

The fundamental idea that the Anthropocene was both scientific and political did not change across the various settings and contexts that eventually came to adopt the concept. From their earliest interactions with the term, to the position they had adopted in late 2016, the AWG and its various members negotiated the Anthropocene concept as something that straddled both. It was a very real physical phenomenon, and a concept through which they could play their own part in illustrating the impacts of humans on the planet. The challenge arose not because the concept had somehow changed when it was imported to stratigraphy, but because it would have to be rewritten in a new language. If AWG members wanted the Anthropocene to do its good work,

they would have to prove it through the language of stratigraphy, or alternatively bend stratigraphy so that it could better reflect the concept. The meaning of the Anthropocene and its hybrid constitution had not changed, but its movement had raised questions about what certain disciplines had the authority to say. The fissures that opened between the AWG and the ICS, and later between the AWG and Erle Ellis when he decided to go it alone, illustrate the vastly different interpretations that were available in response to those questions. That the broader controversy ultimately sought to stabilise a vision of the Anthropocene without resolving these questions first suggests how difficult it is to answer them in practice.

My second research question explored how and why the Anthropocene was given meaning and made to move. While the ESS community and the AWG held relatively straightforward justifications for their adoption of the concept located somewhere in between the physical reality of change and the Anthropocene's potential to foment political action, the answer to this question became increasingly complicated as the parameters of the controversy expanded to take on an increasingly diverse range of actors. Once the AWG had driven the Anthropocene to sufficient prominence, their efforts were met with a wide-ranging response from scholars who placed differing priorities on observation and intervention in their thinking. At the one end, earth and environmental science responses disagreed with the AWG's answer to the lower boundary question - itself an artefact of the nominally epochal status of the Anthropocene - and simply wanted to offer their own more accurate suggestions. In the social sciences and humanities there was a sense that the AWG's efforts were emblematic of the undue prominence given to complicated value considerations when they were embedded within technical concerns. In both cases a specific technical disagreement - over either the dating or the naming of the Anthropocene - masked more fundamental concerns that their own distinct voices would get lost in a conversation to which they felt they could or should otherwise contribute. In the British Society for Geomorphology's Fixed-Term Working Group on the Anthropocene and other 'invisible' disciplines I located groups and individuals that had a less clear sense of what they wanted to 'do' with the Anthropocene. They simply recognised that the conversation

would happen with or without them, and could not afford to miss out. In this sense the very interdisciplinarity of the Anthropocene threatened to leave their own unique voices obscured. At the same time, their decision to adopt the Anthropocene regardless only helped to maintain that interdisciplinarity and hold the Anthropocene beyond the reach of any particular discipline.

As a result, the efforts of these interlocutors to reshape the Anthropocene to better reflect their own thinking and to better suit their own - diverse - needs, inadvertently helped to drive the concept and the controversy to greater prominence. Their adoption of the Anthropocene, despite objections, illustrated broader tensions at play regarding how it is that researchers can make their voices heard in the kinds of far-reaching debates the Anthropocene represented. The AWG might have primarily concerned themselves with importing evidence for global change and processing that through the tools of stratigraphy, but their understanding of the Anthropocene did not translate in the same way to every group that sought to adopt the concept. Rather, the wide-ranging debate that followed illustrated the contested and complex boundaries between science, politics, values, and the different ways that groups negotiated these dimensions with regards to a single epistemic thing. Where the story became even more complicated was in the creation and stabilisation of an informal vision of the Anthropocene through a number of Anthropocene-centred journals. I argued that the spaces that these journals helped to stabilise were not a meeting point for a common understanding of the Anthropocene, but were more simply a space in which long-standing tensions would be brought into inevitable conflict. Despite a well intended 'agreement to agree' that the Anthropocene had some 'inter~' or 'transdisciplinary' value, I argued that underlying differences over how to approach concepts was left unexplored. If the AWG's vision of the Anthropocene had not carried over into this informal space, neither were the various understandings that reverberated within it shared in any coherent way.

My final thematic question asked what implications the controversy had for those involved. For the AWG the answer to that question seems apparent, they had gone from a disparate group of scientists to a group with global recognition and standing. And,

they had consolidated a concept that could generate enough excitement that it would grab the attention of the world's media. That excitement may yet fade, but in doing so the AWG drew enough attention to themselves that prominent voices within the institutional machinery of stratigraphy - at first so keen to endorse their particular investigation - were left at pains to check the groups efforts and defend their discipline. The group had transformed from a pooled resource with a shared understanding that the Anthropocene was real to a group struggling to resolve how they could respond to that reality through the use of the stratigraphic toolset. Their lesser shared understanding of how to negotiate the rules of stratigraphic practice eventually gave way to a series of seemingly acrimonious splits. Each member might have had his or her own sense of how to resolve the tensions between the reality, stratigraphy, and politics of their efforts, but internal differences now threatened to tear the group apart and enhanced external scrutiny endangered their freedom to address the Anthropocene as they saw fit.

What then to say about interdisciplinarity, or the question of science and society? I want to resist the temptation to label the Anthropocene - alongside other increasingly complex scientific narratives that mediate contemporary challenges for society - as somehow 'post-normal' (Hulme 2009; see also Funtowicz & Ravetz 1993; Ravetz & Funtowicz 1999; and with reference to the Anthropocene specifically, Pálsson et al 2013). Insofar as it has been possible to make sense of the Anthropocene by understanding the demarcations, rhetorics and ideologies at play - the very context in which scientific claims are mobilised - The Anthropocene is very much science as usual (Taylor 1996). What the Anthropocene demonstrates is that while there will always be new scientific concepts, scientists, researchers, and the institutions of knowledge production have been far less successful in inculcating the capacity to choose between different concepts where they speak to the same phenomena. The issue with the Anthropocene was that the concept was simply too big: it sat across too many domains for it to be consolidated or meaningfully constrained through any one disciplinary approach and this left it unclear what it was for. In this sense, the Anthropocene came to occupy an intriguing interstitial space between both 'science' and the 'public', but also

between the various disciplines that might mediate upon that 'science'. This meant, in turn, that interlocutors were left arguing over the dual questions of whether they could offer a more authoritative and 'truthful' representation of the Anthropocene, while simultaneously questioning whether their system of representation could do a better job of illustrating the stakes where the public were asked to choose between the different worlds they might bring into being (Mol 1999).

Conceptual material on interdisciplinarity has been extremely good at identifying the various modes under which 'interdisciplinary' efforts take shape, be that the 'integrative-synthesis', 'subordination-service', and 'agonistic-antagonistic' typology offered by Barry, Born, and Wesskalmys (2008, p28), or Theo Van Leeuwen's remarkably similar categories of 'pluralist', 'centralist', and 'integrationist' interdisciplinarity (2005). Within the AWG's membership alone it was possible to discern each of these three typologies in practice. Coming from contemporary earth science approaches, some arguments emanating from the group clearly saw stratigraphy as performing a service to the ESS conception of the Anthropocene. The group's publication in the journal *Earth's Future* on combining ESS and stratigraphic approaches to the Anthropocene consolidated this vision in great detail (Steffen et al 2016). Work by the AWG to produce novel concepts like 'technofossils', 'anthroturbation', and the reclassification of technofossil assemblages in terms of trace fossils and biological evolution (Zalasiewicz, Waters & Williams 2014; Zalasiewicz et al 2014b; Williams et al 2014; 2016) suggests that some of the stratigraphers within the group saw a genuine opportunity to integrate the observations made elsewhere within a recognisably stratigraphic framework. Those AWG members who had expertise in the social studies of science saw the AWG's efforts in terms of a clashing of approaches that would reconfigure more fundamental boundaries and allow the group to press "the historical and epistemological development of stratigraphy" (2x surveys). To this, I might usefully add that AWG members with broader institutional roles within the SQS had another perspective entirely. It was fine for the group as a whole to ruminate on the impacts that a broader set of disciplinary perspectives might have on stratigraphy and vice versa, so long as these did not influence one another in practice. That some members of the AWG

eventually sought to describe their efforts in terms of the birth of a new paradigm, without resolving exactly what that meant in terms of the Anthropocene's disciplinary configuration, suggests that even they were unable to identify how exactly the concept fit together.

Defying a discrete typology, the Anthropocene was less about the production of a set of coherent relationships (whether co-operative or antagonistic) between disciplines, and about how Crutzen's original coinage of the concept established a cascade of burdens across different epistemic communities. Beyond the "curiously asocial" view of any single community attempting to define the boundaries of their own field in isolation to one another (Taylor 1996, p92), the Anthropocene reveals a situation in which disciplines were obligated to respond to claims made at the boundaries of their own areas of expertise in ways that unavoidably pushed their responses back upon others. In this sense, the Anthropocene was interdisciplinary both by design and by accident. That the Anthropocene controversy played out across an increasingly complex "transcontextual tangle" of spheres (King in Lorimer 2016, p118) only complicated things further. By the time the controversy had expanded to its widest it was the very absence of a clear relationship that defined the settlement that was reached over a geological and cultural 'dual life' for the Anthropocene. In this space, the various 'local coordinations' (Galison 1997) by which different interlocutors could navigate the interdisciplinarity of the Anthropocene in any given moment gave way to something far looser. Critically, within this space interlocutors actually benefited from maintaining the Anthropocene within, between, and beyond any particular disciplinary formation. It was only here that the concept could retain the multitudinous interest originally gifted to it by Crutzen.

Where the AWG struggled, conversely, was in the need to prove the Anthropocene through stratigraphy despite their embrace of a far broader vision of the concept. Their vast evidential case for the Anthropocene would count for nothing if they could not agree with the ICS a shared criteria and logic through which to validate that evidence. This intuits a broader problem for the AWG. The differences over which disciplines

came to friction in the controversy were not only about what those disciplines believed they could 'do' (Collins et al 2010) for the Anthropocene, but also what they felt that the concept was 'for'. Where interlocutors all shared a recognition that the Anthropocene concept was somehow both observational and interventionist, they nonetheless disagreed on the extent to which they should put that knowledge into practice, and on whose authority they could do so. There was, in this space, a whole dimension to the Anthropocene controversy that was not subject to disciplinary status and not reducible to epistemic authority. And yet, it was precisely this space that was so critical to understanding the orientations of various disciplines in response to the Anthropocene and its implications. The recourse of some AWG members to a new paradigm when negotiating the space they had helped to create between the Anthropocene and stratigraphy meant appealing to a new, as-yet-nonexistent kind of epistemic authority. This was, in effect, an act of deferral into the future. It meant that in the present the Anthropocene was retained within a space defined by its uncertain boundaries and within which there were unclear limits on the concept's epistemic reach.

With the discipline of stratigraphy lacking the appropriate clout to conduct a 'moral discourse' around the Anthropocene (M. Ellis & Tractenberg 2013), the AWG could retain a central role in guiding the development of the Anthropocene concept so long as the conversation revolved around scientific expertise. Thus, despite the implication that the Anthropocene would matter for the public, it was a notion of scientific authority in its broadest sense that had the most profound differentiating effect on the arguments that were produced. As a result, and in spite of the desire to hold court in the public interest, the public's presence was never really felt. Whatever the outcome, they were simply consumers expected to act on whatever science they were told lest others intervene on their behalf (see Fuller 1993). This is a curious end-state for a concept whose very interdisciplinarity might otherwise imply that it was tackling 'the big problems' in pursuit of societal relevance (see Nowotny et al 2001). In my view, the fine balancing act that left the Anthropocene as both a scientific fact and strangely undetermined actually helped to essentialise the 'scientificity' (Taylor 1996, p223) of the Anthropocene as a claim untouched and removed from its downstream implications. Those with appropriate

experience and familiarity with the process for stratigraphic formalisation, might have recognised that formalisation is always provisional, revocable, and subject to challenge (1x interview), but the language of ‘official recognition’ and ‘stratigraphic formalisation’ carried across contexts in ways that both the membership of the AWG and those involved in the broader controversy seemed to recognise. Whether leveraging the ‘fact’ of global change to prompt a political conversation - or the inverse which saw the adoption of the Anthropocene because it provoked a political conversation that could not otherwise be ignored - interlocutors in the controversy debated the role that the fact of the Anthropocene might play in society without ever addressing the public directly. In so doing, the controversy itself arguably reduced the ‘Anthropocene’ into a kind of ‘outformation’ (Ezrahi 2004) stripped of any cue as to how we might decode and understand it. If the monolithic cultural authority of science in the past risked leading us to “unreflectively sanction a quasi-objectivist demarcation of science” (Taylor 1996, p227), then the unclear disciplinary status of the Anthropocene - trapped as it was between a ‘simple scientific fact’ and a kind of productive ambiguity - in the present risked doing the same thing by disavowing the public of the opportunity to understand either the production or legitimisation of the concept (ibid).

The implications of this go beyond the Anthropocene alone. After all, it is not the only charismatic “mega-category” (Malhi 2017, p6) in play in contemporary discourse around the environment. For example, many of the same scholars have begun to adopt the associated concept of a ‘sixth mass extinction’, including the AWG’s Anthony Barnosky (Barnosky et al 2011) and critical interlocutor Donna Haraway (2016, p43). Much as the Anthropocene raised questions about what authority counts, where, and why, the sixth mass extinction literature has drawn a concerned response from eminent palaeobiologists sceptical of those “making facile comparisons between the current situation and past mass extinctions” with little understanding of just how severe those past events were (Erwin in Brannen 2017, online; c.f. Ceballos, Ehrlich & Dirzo 2017). It may be emotionally satisfying to escalate the narrative of human hubris, but the effect is to leave certain kinds of disciplinary expertise isolated. Much as the Holocene Working Group felt obligated to stress that their rejection of the Anthropocene was not a

disavowal of the severity of anthropogenic change (Walker, Gibbard & Lowe 2015, p3; 1x email), the Smithsonian Institute's Douglas Erwin felt compelled to state publicly that it "is absolutely critical to recognise that I am NOT claiming that humans haven't done great damage" (in Brannen 2017, online). It would be unfair to claim that interdisciplinarity is wrong per se, but this persistent tension about the appropriate domains of expertise suggests that scholars should think carefully about what it is they want to achieve when they embark upon interdisciplinary discourse.

Fundamentally, the tensions that have produced the Anthropocene controversy are not necessarily new. For example, in assessing the spread, development, and altering meanings of the concept of 'sustainable development', Steve Connelly has pointed to similar dynamics (2007). Nonetheless, at stake in the Anthropocene concept was the nature of the interstitial spaces between disciplines and society and how we talk about them. In making sense of them I have followed Taylor's (1996) suggestion that we need to broaden our understanding of the scientific ecosystem such that it can make better sense of the spaces between 'truth' and 'claim' (p96). In this instance, controversy was defined precisely by the spaces between science and non-science, between the claims variously presented and opposed by different communities, and by the 'worlds' interlocutors thought their own particular variations on the Anthropocene could bring into being (Mol 1999). In the twenty years since Taylor's writing certain segments of the literature have become increasingly fluent in the partiality and contingency of science, but the academy as a whole has not found a way to elaborate and discuss that contingency when speaking with society. Suggesting that public acknowledgement of expertise and authority is on the wane, political theorist David Runciman has suggested that when faced with the public disavowal of trust in expertise scientists can choose to double down on notions like 'consensus', 'truth', 'expertise', and the precious certainty of 'facts', or they can try to do something different by reclaiming the space of doubt (2017, online).

For Steven Shapin an understanding of what science is or how it works is less important for the public than knowing where to look for it, recognising the relevant authorities, and

knowing when to place trust in scientific claims (2010, p387). What is challenging for a concept like the Anthropocene when it takes on a kind of interdisciplinary status is not so much a question of how the involved disciplines interact and orient themselves to one another, but a rather more important question of where authority lies and to what effect. Commenting on the use of scientific authority in discussions of the Anthropocene, physicist Steven Corneliusen (2015) has been highly critical of the language used by the journal *Nature* in its editorials about the concept. Drawing attention to the grotesque contortions that climate sceptics go to in response to the arguments of climate scientists, he expressed particular consternation over the framing of the Anthropocene conversation in terms of 'weaponisation', 'political battles', and the 'fate of the planet'. In Corneliusen's view, where aggressive denialist scepticism might emerge in response to the Anthropocene it will be partially justified in its (inevitable) focus on the non-science positions that scientists advocate when they evoke the concept (ibid). Thus, whatever the level of actual 'guilt', scientists acting in their role as 'scientists' and talking about the Anthropocene will "incite accusations of perpetrating a propagandistic enormity" (ibid). They will appear to be using the science of the Anthropocene to side-step a question about consensus and politics, thereby playing - in some distorted way - into the logic of climate denialism.

As geographer Mike Hulme has noted, concepts that express aspects of global change are challenging precisely for the fact that they carry particular technical meanings subject to specific disciplinary formations, methodologies, and authority, alongside looser non-specific meanings in the public imagination (2009). If environmental debates cannot be resolved apolitically through the epistemic activities of expert bodies in any case (see Yearley 2001, p477), then perhaps the solution to cynicism and anti-intellectualism would be to place greater effort into an honest and open conversation about the partiality of science. As Taylor argued more than twenty years ago, "more productive engagements with and judgements on the pressing issues of our time require the crafting of more inclusive, constructive, and democratic rhetorics of science by practitioners, consumers, and critics alike" (1996, p229; also Collingridge & Reeve 1986). Despite the efforts of various interlocutors to hold the concept open, the

Anthropocene controversy seemed to be trapped by this issue of inclusivity in particular. Because the Anthropocene meant everything, it also meant nothing at all. In so doing, the controversy reveals in its own peculiar way the need for a new vernacular for science that could stake its claim to authority through some means other than a rhetoric of representational mastery. If the institutional restructuring of research means that science and scholarship are required to prove their relevance to society (Bornmann 2013), then perhaps we need to replace a conversation about authority, with a broader conversation about trust, and the good reasons we have to trust authority in which situations, and to what ends. The lingering question for the Anthropocene is whether it ever could have supported that conversation, or whether it was simply too expansive from the off.

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Appendices

Appendix 1: Survey for the Members of the Anthropocene Working Group

Notes on this survey:

Thank you in advance for taking the time to complete this survey.

This survey is presented as a fully editable Word document. Please feel free to use as much space as you require to answer each question as fully as possible.

There is no timeline on the completion of this survey, but it is likely that we may wish to contact you at a later date for interview. With this in mind, it would be greatly appreciated if you could return these surveys to us as soon as is feasibly possible.

This survey is made up of 5 sections, consisting of 3-6 questions each and 21 questions in total. Each section starts on a fresh page. It would be helpful if you could maintain this formatting⁸⁰.

Once the survey is completed could you please return it to jacob.barber@ed.ac.uk. Jacob will then share the results with George and Johannes.

Section 1: Encountering the Anthropocene concept

Q1: When, where and how did you first come across the idea of the Anthropocene?

Q2: At what point did you start to actively make use of, or otherwise engage with, the term Anthropocene?

Q3: Could you please provide a personal, non-technical definition of the Anthropocene?

Section 2: The Anthropocene Working Group

Q4: In your own words, what is the of role/mission the of the Anthropocene Working Group?

Q5: Why did you get involved with the Anthropocene Working Group?

⁸⁰ The distributed version of this survey was formatted in font size 12, with each section starting on a new page and multiple blank lines under each question to give participants space to respond fully.

Q6: What contribution(s) have you made to the group?

Q7: As a group which aspects of the Anthropocene do you agree on the most?

Q8: As a group which aspects of the Anthropocene do you disagree on the most?

Section 3: The Anthropocene and Stratigraphy

Q9: What is the importance of stratigraphy in terms of investigating the impacts that humans have had on the planet?

Q10: Does the multi-disciplinarity of the Anthropocene Working Group make this group different from other Working Groups of the International Commission on Stratigraphy?

Q11: Do you see the Anthropocene as different from other divisions of geological time, if so how does it differ in your view?

Q12: Does it matter if the Anthropocene is different from previous divisions in geological time? If so, how?

Q13: Which stratigraphic marker for the Anthropocene do you prefer and why?
Should the Anthropocene be considered as a chronostratigraphic or a geochronological unit?

Section 4: Anthropocene as a formal epoch

Q14: Does formalisation matter for the Anthropocene? Why so?

Q15: Do you think that the Anthropocene *ought to be* formally adopted by the ICS? Why so?

Q16: Do you think that the Anthropocene *will be* formally adopted by the ICS? Why so?

Section 5: The Anthropocene Downstream

Q17: Do you think the term Anthropocene would gain greater currency if it were to be formally adopted? In what communities do you think this will be the case and why?

Q18: To what extent do you think the work of the AWG is a technical, objective stratigraphic discussion, or is there an element of subjectivity or politics or activism in the discussion?

Q19: What, if any, implications might the work of the AWG have for decision-making related to global environmental change?

Q20: How do you deal with the public interest in your work on the Anthropocene, both from lay members of the public, as well as politicians and other kinds of decision-makers?

Q21: Finally, is there anything else that you think we should know about the Anthropocene Working Group and current debates about the Anthropocene? Also, do you have any questions for us?

Appendix 2: Full Participant List

<i>Research Method</i>	<i>Data Collection</i>	<i>(Additional) Affiliations</i>
19x Anthropocene Working Group Members (AWG 1 - 19)		
AWG 1	Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 22nd September 2016.	
	Survey designed and conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
	Email Correspondence between 12th July and 21st September 2016.	
		<i>Think Tank</i>
AWG 2	Skype Interview performed by Johannes Lundershausen - in collaboration with Jacob Barber and George Holmes - on 15th September 2016.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
	Email Correspondence between 29th January and 4th April 2016.	
		<i>British Geological Survey</i>
AWG 3	Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 22nd September 2016.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
	Email Correspondence dated 5th November 2015.	
		<i>Stratigraphy Commission of the Geological Society of London</i> <i>Editorial Board of The Anthropocene Review</i>
AWG 4	Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 14th September 2016.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
	Email Correspondence between 3rd and 4th October 2016.	
		<i>Journalist</i>
AWG 5	Interview performed by George Holmes - in collaboration with Jacob Barber and Johannes Lundershausen - on 2nd February 2017.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 6	Telephone Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 16th August 2016.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
		<i>Subcommission on Quaternary Stratigraphy</i> <i>Stratigraphy Commission of the Geological Society of London</i> <i>Holocene Working Group</i>
AWG 7	Telephone Interview performed by Johannes Lundershausen - in collaboration with Jacob Barber and George Holmes - on 2nd September 2016.	
	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	

AWG 8	<p>Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 30th August 2016.</p> <p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p>	<i>International Geosphere-Biosphere Project</i>
AWG 9	<p>Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 24th October 2016.</p> <p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p>	<i>Subcommission on Quaternary Stratigraphy</i>
AWG 10	<p>Telephone Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 9th August 2016.</p> <p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p> <p>Introducing the Anthropocene - Retiral Performance shared by the author.</p>	
AWG 11	<p>Skype Interview performed by Johannes Lundershausen - in collaboration with Jacob Barber and George Holmes - on 12th September 2016.</p> <p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p>	<i>Stratigraphy Commission of the Geological Society of London</i>
AWG 12	<p>Skype Interview performed by Jacob Barber - in collaboration with Johannes Lundershausen and George Holmes - on 10th August 2016.</p> <p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p>	
AWG 13	<p>Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.</p> <p>Email Correspondence between 18th and 27th July 2016.</p>	
AWG 14	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 15	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 16	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 17	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 18	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
AWG 19	Survey designed and Conducted by Jacob Barber, Johannes Lundershausen, and George Holmes.	
13x 'technically' motivated interlocutors (TEC 1 - 13)		
TEC 1	Interview performed by Jacob Barber on 17th September 2015.	<i>Archaeology</i>
TEC 2 & 3	Joint Skype Interview performed by Jacob Barber on 30th May 2016.	<i>Pedology</i>
TEC 4	Skype Interview performed by Jacob Barber on 15th June 2016.	<i>Environmental Science</i>
TEC 5	Skype Interview performed by Jacob Barber on 3rd August 2016	<i>Earth system science</i>

TEC 6	Skype Interview performed by Jacob Barber on 27th September 2016.	<i>Climate Science</i>
TEC 7	Skype Interview performed by Jacob Barber on 14th April 2016.	<i>British Society for Geomorphology Fixed-Term Working Group</i>
TEC 8	Interview performed by Jacob Barber on 7th August 2015.	<i>Editorial board of Anthropocene</i>
TEC 9	Skype Interview performed by Jacob Barber on 19th February 2016.	<i>Quaternary Science - Climate Change Advisor</i>
TEC 10	Email Correspondence between 11th and 12th May 2016.	<i>British Society for Geomorphology Fixed-Term Working Group</i>
TEC 11	Email Correspondence between 26th May and 12th September 2016.	<i>Ecology</i>
TEC 12	Skype Interview performed by Jacob Barber on 3rd May 2016.	<i>Climate Science</i>
TEC 13	Email Correspondence between 11th and 20th May 2016.	<i>Physical Geography</i>
TEC 14	Email Correspondence between 4th May and 1st June 2016.	<i>Ecology</i>
12x 'politically' motivated interlocutors (POL 1 - 12)		
POL 1	Telephone Interview performed by Jacob Barber on 12th August 2016.	<i>Holocene Working Group</i>
POL 2	Telephone Interview performed by Jacob Barber on 1st August 2016.	<i>Neomarxist Critique</i>
POL 3	Skype Interview performed by Jacob Barber on 3rd June 2016.	<i>Communications Director for Stockholm Resilience Centre and Future Earth</i>
POL 4	Skype Interview performed by Jacob Barber on 23rd November 2016.	<i>Geopolitics</i>
POL 5	Skype Interview performed by Jacob Barber on 26th May 2016.	<i>Environmental Economist</i>
POL 6	Skype Interview. Performed by Jacob Barber on 27th July 2016.	<i>Popular Writer</i>
POL 7	Email Correspondence between 17th and 21st August 2016.	<i>Environmental Journalist - Popular Writer</i>
POL 8	Interview performed by Jacob Barber on 24th May 2016.	<i>Haus der Kulturen der Welt Curator</i>
POL 9	Skype Interview performed by Jacob Barber on 11th April 2016	<i>Environmental Philosophy</i>
POL 10	Email Correspondence between 18th July 2016 and 19th January 2017	<i>Postcolonial Studies</i>
POL 11	Email Correspondence between 9th and 15th August 2016.	<i>Human Geography</i>
POL 12	Email Correspondence between 13th July 2016 and 23rd August 2016	<i>Textbook author</i>
2x Anthropocene-centred journal editors (ED 1 - 2)		
ED 1	Telephone Interview performed by Jacob Barber on 3rd June 2016.	<i>Anthropology</i>
ED 2	Skype Interview performed by Jacob Barber on 8th June 2016.	<i>Ecology</i>
		<i>Neomarxist Critique</i>

8x 'Anthropocene'-named research group members (GRU 1 - 8)		
GRU 1	Interview performed by Jacob Barber on 5th August 2015.	
GRU 2	Interview performed by Jacob Barber on 25th September 2015.	
GRU 3	Interview performed by Jacob Barber on 11th September 2015.	
GRU 4	Interview performed by Jacob Barber on 7th August 2015.	
GRU 5	Interview performed by Jacob Barber on 11th September 2015.	
GRU 6	Interview performed by Jacob Barber on 22nd July 2015.	
GRU 7	Interview performed by Jacob Barber on 5th August 2015.	
GRU 8	Interview performed by Jacob Barber on 9th June 2016.	

Appendix 3: Collaboration over access to the Anthropocene Working Group

As detailed in the methodology the Anthropocene Working Group placed some limitations on access to their members. As a response I had to collaborate in the production of survey and interview data as pertains the AWG. This collaboration was a necessary condition of access without which this research could not have been completed.

The four researchers who originally contacted the AWG were Prof. Noel Castree (Wollongong University), Dr. George Holmes (University of Leeds), PhD student Johannes Lundershausen (University of Tuebingen), and me. Upon receipt of the email suggesting that we work together in return for access I took a proactive role in facilitating this collaboration. This included initiating and maintaining contact with this group, producing a collaboration protocol with the help of one of my supervisors, and encouraging each of us to produce a synopsis of our work to disseminate to one another in order to discern areas for potential collaboration. I was the only one of the four of us to attempt to do this, and often had to prompt responses from the others. Due to the lack of response from Prof. Castree - and after consulting with Dr. Holmes, Johannes, and my supervisors - I ultimately made the decision to omit him from the project despite his request to be granted access to the data.

I took the lead on drafting the survey for distribution to the AWG, and in organising the additional questions that were submitted by Dr. Holmes and Johannes. I distributed the survey to the gatekeeper - the AWG secretary - and surveys were returned to me whereupon I distributed them back to Dr. Holmes and Johannes. I maintained my role as facilitator by chasing the gatekeeper for further responses to the survey and having these reminders included in updates sent to the membership of the AWG. Based on analyses of the survey responses I took the lead in producing the interview schedules that followed. Of the 12 interviews performed on AWG members I performed 8. Based on timings, availability and a wish to maintain access to the data set Johannes performed 3 interviews and Dr. Holmes performed 1.

As argued above, I was critical to the success of this collaboration. Crucially, despite working together in some capacity to produce data, I performed my own analysis upon it that data and can confidently claim sole authorship of my own analysis. Collaboration was not organic and required its own kind of work, but ultimately resulted in a shared correspondence in the journal 'Nature' (as Holmes, Barber & Lundershausen 2017).

Appendix 4: Example Information Sheet and Consent Form



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EH8 9XP.

(+44)7907 770094

Jacob.Barber@ed.ac.uk

Dear Participant,

Disciplinarity, Epistemic Friction, and the 'Anthropocene'

Information Sheet for Participants

Introduction

I am from the University of Edinburgh, School of GeoSciences, Institute of Geography. I am currently collecting data for my PhD project on the social construction of the 'Anthropocene'. My supervisory team consists of [Dr. Franklin Ginn](#) (Lecturer in Human Geography, now at Bristol University) and [Dr Pablo Schyfter](#) (Lecturer in the Sociology of Knowledge). In addition to my core team I have a supplementary administrative supervisor [Dr. Janet Fisher](#) (Chancellor's Fellow). If for whatever reason you wished to contact my supervisory team rather than contacting me directly, please do not hesitate to do so.

This information sheet is intended for interview participants in my research.

It outlines:

- the aims of my research

- what I am asking for in terms of participation
- the responsibilities that I have towards my participants.

Aims

My research aims to explore the 'Anthropocene' concept, and the sustained intellectual debate that has emerged in response to the possibility of formally ratifying that term to the geological time scale. As a term that has travelled very widely and very rapidly, and as one that is heavily debated, the 'Anthropocene' provides a useful entry point to ask a number of questions:

- How and on what grounds, by whom, and why have arguments been made for and against the formalisation of an 'Anthropocene' epoch?
- Why has the 'Anthropocene' provoked such a strong cross disciplinary reaction, and what does that teach us about the ways in which knowledge travels.
- What can the 'Anthropocene' and the debates surrounding its formalisation teach us about the nature of disciplinarity?

As well as producing what is - in some sense - an intellectual history of the 'Anthropocene' debate/discussion, I hope to produce a piece of work that provides a valuable analysis of how knowledge moves in and across the different disciplines that have negotiated with that term. Of particular interest is the way in which different epistemologies come into tension with one another, and what the 'Anthropocene' can teach us about how disciplines work.

This kind of sociological insight into how science works can be incredibly valuable in communicating what we do as academics, and can assist us in finding new ways of talking to and working with one another across disciplinary lines in an age where increasing pressure is put upon academics to build forms of 'interdisciplinarity' into their work. It can be beneficial to know how and where different research practices and methodologies create confusion, it facilitates the kind of conversations that are becoming essential as we attempt to tackle the environmental and social problems that the 'Anthropocene' seems to so neatly encapsulate.

Interviews and Participation

I wish to perform an interview of approximately 60 minutes (or less) with my participants. In this time I will be asking some questions about the term 'Anthropocene', what it means, as well as how you interact with and use this term in your research. During my pilot study I found that the conversations would often extend into a number of different topics including public understanding of science, the threat of drastic climate change, and personal motivations for research. These additional insights have proved to be extremely useful and I have designed a semi-structured interview format to take advantage of these opportunities to go '*off-piste*'. Questions are designed to facilitate my participants sharing insight with me, rather than my extracting specific answers. I invite participants to help me share in the research process, for example by offering other questions and line of inquiry that I have not considered.

Consent

I am asking you to sign this form to confirm that you have agreed to be interviewed. You do not have to answer any questions if you do not want to and you can stop the interview at any point. You may ask to withdraw from the research at any time (including after the interview has taken place) ceasing any involvement in this project. With your permission interviews will be digitally recorded and then transcribed to aid in analysis. You may ask for any section of your interview to be omitted from analysis (in which case that part of the interview will be deleted). You may also ask for a copy of the transcribed interview to review.

Your name and any other personal information, such as organisational affiliation, can be made anonymous at your discretion. The information collected from interviews will be securely stored in line with the [Data Protection Act \(1998\)](#) and destroyed after my research has been completed.

Risks

There are no risks associated with the research. I intend to tell a positive story about the 'Anthropocene' as an example of how and where researchers from different epistemic backgrounds can run into friction, and the ways they negotiate that friction in order to communicate their research. My research is designed to teach us something about

disciplinarity, and the movement of knowledge. Many of my participants will have different views on what the 'Anthropocene' might mean, but making any kind of judgement about the 'rightness' or 'wrongness' of the 'Anthropocene' is not the intention of this research. Please do contact me if you have any hesitations about this.

Privacy and Confidentiality

Your privacy and confidentiality will be maintained throughout the research process. Interview recordings and transcripts are stored on a secure computer, and in accordance with the Data Protection Act will be destroyed upon completion of this piece of research. Any and all information that refers to individual and institutional specifics can be anonymised upon request. As the consent form makes clear, participants are welcome to withdraw their consent for me to use interview materials at any time.

* * * * *

As a final note, please feel free to contact me at any time during the research process if you have any further questions, wish to modify your consent, or have anything else you wish to discuss.

Thank you for your participation,



Jacob Barber
UNIVERSITY of EDINBURGH

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Institute of Geography &
The Lived Environment,
University of Edinburgh,
Drummond Street,
Edinburgh,
EH8 9XP.

(+44)7907 770094

Jacob.Barber@ed.ac.uk

Dear Participant,

Disciplinarity, Epistemic Friction, and the 'Anthropocene'

Consent Form

I am a postgraduate student at the University of Edinburgh carrying out research for my PhD thesis. My research is concerned with disciplinarity, the movement of knowledge, and epistemic friction as explored through debates about the 'Anthropocene'.

I am asking you to sign this form to confirm that you have agreed to be interviewed. You do not have to answer any questions if you do not want to and you can stop the interview at any point. You may ask to withdraw from the research at any time (including after the interview has taken place) ceasing any involvement with this project. With your permission interviews will be digitally recorded and then transcribed to aid in analysis. You may ask for any section of your interview to be omitted from analysis (in which case that part of the interview will be deleted). You may also ask for a copy of the transcribed interview to review.

Your name and any other personal information, such as organisational affiliation, can be made anonymous at your discretion. The information collected from interviews will be

securely stored in line with the [Data Protection Act \(1998\)](#) and destroyed after my research has been completed.

This form continues overleaf.

I agree to be interviewed by Jacob Barber Yes ☐ No ☐

I consent to interviews and discussions
being digitally recorded where appropriate Yes ☐ No ☐

Signed:

Date:

Print Name:

Thank you for your participation,



Jacob Barber

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